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Feed quality of some populations and varieties of sorghum

F. ALANE[1,♥], H. RAHALE-BOUZIANE[2], Z. FADJER[2]
[1]Animal Production Division, National Institute of Agronomic Research of Algeria (INRAA) Baraki. 2 rue les frères OUADEK-BP N 200 Hassen Badi-16200-El Harrach, Alger 16200, Aljazair. Tel.: +213-23 82 85 64, ♥email: alanefarida@hotmail.fr
[2]Genetic Resources Division, National Institute of Agronomic Research of Algeria (INRAA) Baraki. 2 rue les frères OUADEK-BP N 200 Hassen Badi-16200-El Harrach, Alger 16200, Aljazair

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Abstract. *Alane F, Rahale-Bouziane H, Fadjer Z. 2020. Feed quality of some populations and varieties of sorghum. Asian J Agric 4: 5-13.* This research aimed to characterize some local populations and those from ACSAD through two trials. The Sudan population is believed to be better than the other two local populations. There is one with an average height of 55.07 cm and an average number of tillers per square meter 128/m², that offers a green and dry yield of 5311.47 g/m² and 497.2 g/m² respectively. In the second test, the comparison of the chemical composition of the pasty milky and hard grain stages did not register a big difference. CP was almost the same (6.66% and 6.1%). The varieties Masser 17, Ezzera, and Biofuel from milky-pasty stage to hard grain stage has their cellulose rate decrease. The maturity of the seed is reached between 82 and 92 days after sowing and their sizes vary between 71 cm and 1.26 m. The average cellulose level of milky-pasty populations is 26.08% and the hard-grain stage is 28.44%. The analysis of the principal components at the hard grain stage has constituted two groups: Kherssi, Beida Adrar, Tougourte, Ain Sallah. Ezzera, Biofuel, Masser17, El Menea. Greater diversity in the chemical composition of the stems, than in those of the leaves more digested was observed.

Keywords: Biometrics, chemical composition, sorghum

INTRODUCTION

Sorghum cultivation covers 41.57 million hectares, in the tropical region from which it originates, but also in the temperate region (FAO 2001). *Sorghum* ranks are fifth in cereals, after wheat, rice, maize, and barley. But it comes second, after maize in Africa (Chantereau et al. 1997), where production reaches 18.78 million tons. The main producing countries on this continent are Nigeria (7.71 million tons) and Sudan (over 2.49 million tons). Asia produces 11.43 million tons of grain, of which 7.42 million tons in India. Globally, the United States is the leading producer with 13.61 million tons (FAO 2001).

In the United States and other developed countries in general, grain *sorghum* is reserved for animal feed. It has experienced a revival of interest with the spread of varieties without tannins, and therefore better food value. New industrial opportunities have emerged: *sorghum* fiber for paper mills and sweet sorghums for biofuel production (Chantereau et al.1997).

In 1753, Linnaeus described in Species Plantanum three species of cultivated *Sorghum: Holcus sorghum, Holcus saccaratus,* and *Holcus bicolor*. In 1805, Person suggested the name *Sorghum* for *Holcus sorghum* (L). In 1961, Clayton proposed the name of *Sorghum bicolor(L.) Moench* for cultivated *sorghum* and it is this name that is currently used (FAO 1995).

Sorghum cultivation had occupied a significant place in Algeria. Around the middle of this century (1943-47), grain *sorghum* was heavily used by local people to fight famine. The common white *sorghum* of Kabylia: these forms fall into the group of loose-tailed *sorghum* (*Sorghum vulgare L.* var.effusus Korn.) Which includes broom (*Sorghum vulgare* var technicus Korn.) and *sweet sorghum* (*Sorghum vulgare var.saccharatus* L.). Both were poorly cultivated in colonial times in Algeria; the first for its tassel and the second for its stalks and leaves which constitute an excellent forage after silage. In addition to the above varieties, *sorghum* from Sudan or *sorghum menu* (*Sorghum exiguum Forsk.*) were introduced to Algeria by Trabut (INRAA 2006).

The family of *sorghum* (Sudan grass) has stems and fine leaves. The sweet *sorghum* family has big stems (hence the name *cane*) and broad leaves. The hybrids (*Sudan grass* x *sweet sorghums*) are more or less different depending on whether the character Sudan grass or sweet sorghum prevails in the hybridization (Grenet et Cie, ND). The fineness of the stalks of the Sudan-grass allows it to be widely used: in green, in tedding (after pre-wilting of a day), or in silage.

The *sweet sorghum* whose stem size gives these plants the name "cane", has importance in presence of sugar. The range of precocity is quite broad. Hence two essential vocations, silage, and consumption in green at the barn (Grenet et Cie, ND).

In 1948, Laument spoke of the interest of forage *sorghum* as great, if neither corn can come without irrigation in fresh land (*sorghum menu*) or irrigated *sweet sorghum*. Both sweet and *sweet sorghums* are susceptible to irrigated crops of high simultaneous yields in grain and hardwood stems. The mowing is done at the formation of grains (before the risk of an accident by hydrocyanic acid). According to Borghi et al. (2013), *sorghum* is an excellent intercropping in poor soil where corn does not grow very well and provides large amounts of biomass.

Sorghum sudanense originates from Egyptian Sudan and is cultivated largely as a forage plant (*Sorghum menu*, Sudan-grass of the Americans). It is slightly slender and ranges from 2 to 3m long, with slightly hazy glabrous under the nodes (Maire et al. 1952).

Sorghum autogamy was exploited to obtain selected, short-cut, mechanically-harvested lines that quickly conquered the great plains of the south and central Midwestern states of America. Subsequently, these lines were replaced by hybrids (Chantereau et al. 1997). This improved the digestibility of *sorghum* matter, which contributes to higher productivity of livestock consuming dual-use sorghum (*Sorghum bicolor* L. Moench) (Vietor et al. 2010).

The names given by the farmers to the five Ethiopian local varieties among the 117 varieties are consistent with the Canonical Discriminant Analysis Study (CDA) and the Modeclus Cluster Analysis. Indeed, they formed dissimilar groups. The color of the median vein, the color of the grains, the size of the grains, the color of the glume, the hairiness of the glume and the shape of the grains were the morphological characters used by the farmers to name these local varieties of *sorghum*. These local varieties are to be protected.

The biometric parameters are determined of local populations and from ACSAD (Arab Center for the Studies of Arid Zones and Dry Lands, Syria) variety; in this work, we have determined the chemical composition of these same populations at two different stages: milky-pasty and hard grains of the whole plant, and organs leaves and stems separately.

MATERIALS AND METHOD

The plant material

The local seed was collected in 2012 from farmers in Algeria (Adrar wilaya) located 1330 km south of the capital. The first test was installed on 30/06/2013 at a dose of 3 seeds per pouch.

A second trial was conducted in 2015, with the introduction of eight ACSAD seed varieties (Syria). The origin, color, and weight of 1000 seeds of these populations are shown in Table 1.

The site and experimental device

The experimental device is composed of a completely random block type with three repetitions covering an area of 640,5 m². Seeding took place in open fields in a greenhouse covered by a net, at the Baraki experimental station of the National Institute of Agronomic Research of Algeria (INRAA). Located in Algeria, whose geographical coordinates are: 36 ° 41'4,35"Nord and at 3 ° 06'24,84"Est and an altitude of 18,5m. The seedling dose was 3 grams per bag. Fifteen days after germination, we left one plant per pouch. The first mowing was done 52 days after planting at the vegetative stage at an average of 40 cm.

The climate and irrigation

The climate of the region is like the Mediterranean. As it is located in the subhumid bioclimatic stage, it is characterized by a rainy season going on average from September to May, and by a sunny summer (Seltzer 1949).

Mean and maximum temperatures during the first week of the first test were 15 ° C and 23.3 ° C, respectively. The maximum rainfall recorded during the experimental period was 16 mm in October.

Mean temperatures during the first month of the second test installed on 4/05/2015 were 19.9°C. The rainfall accumulated at the climatic station during the experimental period is 245.2 mm. The maximum rainfall recorded during the experimental period was during October and November, with 91.6 mm, and 92.4 mm respectively (Table 2). The average temperature of the seven months of experimentation was 22.39°C, the maximum temperature was 27.2 recorded in August and the minimum was 19.9°C in April. The humidity of the air was high throughout the experimental period with an average of 72.13%.

Irrigation water was added to supplement the water deficit at the beginning of vegetation twice a week and at the end of vegetation once a week.

The soil

The physicochemical analysis of the soil shows a loamy clay structure (triangle of soil structure), a basic pH (7.87), and an electrical conductivity of 0.28 d/m which shows that the soil is not very salty. The nitrogen content is 0.034%. On the other hand, the phosphorus content is very high at 53.15 ppm and high for potassium 0.67 meq/g.

Table1. Origins, color, and weight of 1000 seeds of studied populations

Populations	Colors	Origins	Weight 1000 seeds
Hamra	Red	Algeria	40.16
Beïda	White	Algeria	31.13
Biofuel	White	ACSAD	40.4
Insallah	White	Algria	39.3
Ezraa	White	ACSAD	36.8
Tougourte	Black	Algeria	31.4
Masser 17	White	ACSAD	34.6
El Ménea	Black	Algeria	42.4
Dorado9	White	ACSAD	37.5
Kharsi	Red	Algeria	47

Table 2. Climatic data of the period of the test

Year	Precipitation (mm)	Temperature (°C)	humidity (%)
Months	Amount	Average	Average
2015-05	14	19.9	69.3
2015-06	14.4	23	70
2015-07	13.2	27.2	70.4
2015-08	7.2	27.3	70.9
2015-09	12.4	24	67.8
2015-10	91.6	20.6	74.5
2015-11	92.4	14.7	82
2015-12	245.20	22.39	72.13

RESULTS AND DISCUSSION

All the forage yield parameters in Table 3 show that the Sudan population is better than the other two populations. Indeed, this one with an average height of 55.07 cm and an average number of tiller per square meter 128/m², offers a green and dry yield of 5311.47 and 497.2 respectively.

In the milky-pasty stage, the chemical composition of these three populations, i.e., Hamra, Sudan, and Beida Adrar are different for the whole plant. The dry matter content is 92.5%, 94.5% and 94.85% respectively. Mean is 93.95% relatively the same in both leaf and stem organs separately (Table 4). The highest average mineral content is in the leaves (10.56% DM), the Hamra rate exceeds that of the other two populations. The average rate of mineral matter in the stems of the three populations is 5.98 %, not far from the average of the plants of the three populations (7.34%) (Table 4). The result of the ash content is greater than the average found in the organs and the straw of 194 Burkina Faso lineages, the straw offers 7% DM, the leaves 6.5% DM, and the stems 2.5% MS (Kondombo 2001).

The two other total nitrogen and crude cellulose antagonist parameters are determinants of digestibility in ruminant animals, showing a high average total leaf nitrogen content of the three populations (11.73%) (Table 5) with a higher Hamra leaf (12.92). The stems of the three populations record an average of 4.95% whereas the whole plant at this stage offers an average in all three populations of 7.66%. Burkinabé lines offer lower rates: leaves between 4.3-7%, which stems between 2-5.6% straw between 2.8-5.7% dry matter (Kondombo 2001). In Tunisia, in the milky-pasty stage, the content was 5.2% (Znaidi et al. 2010).

The level of fiber is high in the Sudan population, either in the organs or the whole plant (Tables 4 and 5), even though the population has fine stems and is therefore mainly intended for fodder production. Its pasty milky-pasty stage has 32.73% lower than the average gross yield at the same stage in Znaidi et al. (2010) 38.51%. The average of the plants of the three populations is 28.57% CF, the same average of the stems of the three populations 28.10% higher than the average of the leaves 24.85% (Table 5). The leaves of the Hamra offer a cellulose level of 23.31% lower than the rate of the other two populations. The average leaf rate in the green of this population is 28.91% and a dry leaf-to-stem ratio of 0.38% slightly lower than the Beida Adrar population ratio of 0.42% (Table 6). The average ratio of Burkinabe lineages is 0.49, the minimum is 0.25 and the maximum is 0.8 (Kondombo 2001).

The analysis of the variance of the chemical composition of the plants of the three populations, shows a very highly significant difference in the two parameters DM and CF (Table 7). On the other hand, at the stem level, the chemical composition shows a significant difference in the DM and the MM and a very significant difference in CF and none in CF (Table 9). At the leaf level, the analysis of variance is highly significant for MS and MM and very highly significant for CP and CF (Table 11).

Thus, to compare the populations, the moisture content and the crude cellulose content of the whole plant are examined. To compare the digestibility of the populations, we checked the content of CP and CF of the leaves (the leaf to stems ratio).

There was a very high positive correlation between CP and MM, a very high negative correlation between CF and MM in the whole plant of the three populations. A high negative correlation between crude cellulose and CP (Table 8). There was no correlation between the chemical parameters of leaves and stems (Tables 10 and 12).

Table 3. Green and dry yield and average height and number of talle/m² of local populations

Populations	GM g/m²	DM g/m²	Height in cm	Number of tillers/m²
Hamra	2517,19	258,53	35,97	81,33
Beida Adrar	2707,2	315,73	31,03	98,67
Sudan	5311,47	497,2	55,07	128

Table 4. Chemical composition of the *sorghum* plant of 2013-2014 at milky-pasty milk stage

Populations	In% of dry matter			
	DM%	MM%	CP%	CF%
Hamra	92.51	8.36	8.08	27.07
Sudane	94.49	6.10	7.001	32.73
Beida Adrar	94.85	7.55	7.91	25.92
Average	93.95	7.34	7.66	28.57

Table 6. Proportion of leaves and stems in the plant population and the ratio of leaves to stems

Populations	% of leaves in green	% of the stems in green	Report leaf on stems in sec
Hamra	28.91	69.42	0.38
Beida Adrar	35.32	78.037	0.42

Table 5. Chemical composition of stems and leaves of *sorghum* of companion 2013/2014 at milky-paste stage

Populations	Rods				Leaves			
	DM%	MM %DM	CP %DM	CF %DM	DM%	MM %DM	CP %DM	CF %DM
Sudan	93.74	6.29	5.28	31.16	92.89	10.50	10.93	26.57
Beida Adrar	93.36	5.63	4.70	26.38	93.36	9.67	11.35	24.67
Hamra	93.32	6.03	4.88	26.77	92.97	11.51	12.92	23.31
Average	93.47	5.98	4.95	28.10	93.08	10.56	11.73	24.85

Table 7. Analysis of the variance of the chemical parameters of the plants of the three local populations at the milky-pasty stage.

	Variance	DDL	Chi2	P	Meaning
MS%	3.507	8	28. 056	0.0009	***
MM%	1.360	8	10.883	0.4169	NM
MAT%	0.702	8	5.613	0.6191	NM
CB%	16.761	8	134.091	0<0.0001	***

NM: no significant ; *: significant; ***: very highly significant

Table 8. Correlation matrix of the chemical parameters of the plants of the three local populations at the milky-pasty stage

	MS%	MM%	MAT%	CB%
MS%	1			
MM%	-0. 164	1		
MAT%	-0.280	0.826	1	
CB%	-0.243	-0.882	-0.744	1

Dd1 = 9-2 = 7 α = 0.1 rth = 0.58 (*). α = 0.05 rth = 0.66 (**). α = 0.01 rth = 0.79 (***)

Table 9. Analysis of the variance of the chemical parameters of the stems of the three local populations at the milky-pasty stage

	Variance	DDL	Chi2	P	Meaning
MS%	0.249	8	1.994	0.0376	*
MM%	0.260	8	2.044	0.0429	*
MAT%	0.404	8	3.229	0.1617	NM
CB%	22.430	8	179.442	0<0.0001	***

NM: no significant ; *: significant; ***: very highly significant

Table 10. Correlation matrix of the chemical parameters of the stems of the three local populations at the milky-pasty stage

	MS%	MM%	MAT%	CB%
MS%	1			
MM%	-0. 512	1		
MAT%	0.012	-0.131	1	
CB%	-0.404	0.294	0.429	1

Dd1 = 9-2 = 7 α = 0.1 rth = 0.58 (*). α = 0.05 rth = 0.66 (**). α = 0.01 rth = 0.79 (***)

Table 11. Analysis of the variance of the chemical parameters of the leaves of the three local populations in the milky-pasty stage

	Variance	DDL	Chi2	P	Meaning
MS%	0.118	8	0.948	0.0029	**
MM%	3.259	8	26.070	0.0020	**
MAT%	5.379	8	43.033	0<0.0001	***
CB%	4.276	8	34.209	0<0.0001	***

*: significant; ** : very significant. ***: very highly significant

Table 12. Correlation matrix of the chemical parameters of the leaves of the three local populations in the milky-pasty stage

	MS%	MM%	MAT%	CB%
MS%	1			
MM%	-0. 182	1		
MAT%	0.385	0.131	1	
CB%	0.005	0.375	-0.191	1

Dd1 = 9-2 = 7 α = 0.1 rth = 0.58 (*), α = 0.05 rth = 0.66 (**), α = 0.01 rth = 0.79 (***)

In the second trial of 2014/2015, in addition to the three populations of the first trial, we added ten populations (local) and varieties (ACSAD). Two physiological stages were to be analyzed: the milky-pasty stage and the hard grains stage. The comparison of the chemical composition of these two stages did not register a big difference. In fact, the average level of CP was almost the same at both stages (6.656% and 6.089%), with a slight increase in the other chemical parameters of the milky-pasty stage at the hard grain stage (Table 13).

In addition, some varieties and populations did not follow this progression. Since the varieties, Masser 17, Ezzera, and Biofuel of the milky-pasty stage at the hard grain stage, their cellulose content began to decrease (Table 13). This can be explained by the decrease in the bark-to-marrow ratio of their stems (Table 14), so at the hard-grain stage, there was a synthesis of parenchymal tissues at the central level of the stem. Also, these varieties are characterized by a short cycle and a short size. The maturity of the seed is reached between 82 and 92 days after sowing and their sizes vary between 71cm and 1.26m (Table 14). The average cellulose content of milky-pasty populations was 26.08% and the hard-grain stage was 28.44% (Table 14), which is lower than the values given by the Jarrige tables (1988) at the milky-pasty stage. 30.7% CF and 6.9% CP.

The analysis of the variance shows a highly significant difference between populations and varieties for the DM parameter and a very highly significant difference between the CP and CF variables (Table 15).

Table 16 shows that milky-pasty DM is very highly negatively correlated with CP and highly positively correlated with MM and CB. The two chemical parameters MM and CF are very highly correlated.

Table 17 shows a correlation at the very high positive hard grain stage between CF and MM, very highly negative between CF and CP The correlation between MM and DM is highly positive.

The average content or the highest requirements for minerals in the milky-pasty stage are marked in the Tougourte population and the lowest is in El Menea, Biofuel, and Ezzera (Figure 1). While the needs are high at the hard grain stage at El Menea, Tougourte, Kharssi, and Beida Adrar. The first two populations are hybrids with fine stems <2mm and high height of about 1.5m (Table 14), easy to fade select for forage production. The lowest need for MM is recorded in biofuel (Figure 2).

The highest CP content in the two stages was studied. was marked in the Biofuel variety (9.1%) at the milky-pasty stage and 7.03% at the hard grains stage (Figures 3-4, Table 13). The lowest was at Ain sallah at the milky-pasty stage, and Ain sallah and Kherssi at the hard grain stage. They are two populations that are exploited mainly to produce seeds at the level of Oases and arid zones. The population of Ain sallah is taller and with big stems (1.72cm), with broad leaves and a very long cycle of 128.5 days, its panicles are large and compact. After harvesting the plant, it can feed the animals with a supply of nitrogen concentrate. The population Kherssi, is shorter than Ain Sallah, but richer in nitrogen at the milky-pasty stage, at the hard grain stage it produces vegetables, but it is characterized by the presence of the pigments that oasis women use as dyeing.

In the milky-pasty stage (Figure 5), the highest crude fiber content is found in the Tougourte population and the lowest in the El Menéa population respectively 30.59%, 21.57% (Table 13). 30% of content is good (Jarrige 1988, 1995).

Table 13. Chemical composition of ten populations and varieties of sorghum at milky-pasty and hard grain stages

Populations and varieties	Milky-pasty stage in %DM				Hard grain stage in %DM			
	DM%	MM %	CP%	CF %	DM%	MM%	CP%	CF
AinSallah	93.751	6.978	4.133	27.67	94.476	7.776	4.712	32.07
Khersi	93.575	7.245	8.121	26.28	92.738	8.930	3.886	32.69
Masser17	93.400	7.135	8.652	27.38	94.437	8.143	7.113	24.53
Ezzera	92.696	6.264	8.583	23.62	94.310	7.906	7.576	21.78
Tougourte	93.974	8.868	6.289	30.59	94.475	9.019	4.956	32.90
Biofiuel	92.904	6.692	9.089	24.67	94.759	7.641	7.027	21.39
El Menea	93.474	6.094	6.085	21.57	94.626	9.341	8.082	32.33
Beida Adrar	93.190	7.131	5.563	26.43	94.511	8.288	5.357	29.88
Dorado9	94.638	7.178	3.388	26.52	-	-	-	-
Average	93.511	7.065	6.656	26.08	94.291	8.381	6.089	28.444

Table 14. Biometric parameters of ten populations and varieties of sorghum at milky-pasty and hard grain stages

Populations and varieties	Milky-pasty stage					Hard grain stage	
	Cycle (day)	Height (cm or m)	Diameter of stems(mm or cm)	Bark /Moelle ratio (sec.)	The report sheets/stems	Cycle (day)	Bark/Moelle ratio (sec.)
In Sallah	60	1.4667m	1.72 cm	2.84	0.29	128.5	1.560
Khersi	35	1.2975m	12.35mm	2.50	0.5	111.33	4.125
Masser17	35	1.2225m	11.275mm	3.92	0.24	92.33	2.800
Ezzera	35	1.2575m	10.385mm	3.63	0.23	85.33	2.475
Tougourte	39	1.43m	1.77mm	3.75	0.30	106	1.980
Biofuel	35	70.67cm	18.63mm	2.53	-	82	2.270
El Ménéa	60	1.5367m	1.525mm	5.25	0.2	105.67	3.33
Beida Adrar	35	1.3525m	17.2mm	3.13	0.3	81	1.60
Dorado 9	60	96.33cm	2.22mm	2.95	0.4	106	2.32
Hamra	-	-	-	-	-	115	1.48

Table 15. Variance analysis of the ten milky-pasty populations and varieties of *sorghum*

	Variance	DDL	Chi2	P	Meaning
MS%	0.373	26	9.701	0.0031	**
MM%	0.675	26	17.557	0.2174	NM
MAT%	4.491	26	116.459	0<0.0001	***
CB%	8.527	26	221.706	0<0.0001	***

NM: no significant; **: very significant. ***: very highly significant

Table 16. Correlation matrix of the ten milky-pasty populations and varieties of *sorghum*

	DM%	MM%	CP%	CF%
DM%	1			
MM%	0.428**	1		
CP%	-0.658***	-0.085	1	
CF%	0.358**	0.721***	-0.179	1

Ddl=15-2=25 α=0.1 rth=0.323 (*), α=0.05 rth=0.381 (**), α=0.01 rth=0.487(***)

Table 17. Correlation matrix of ten populations and varieties of hard grain *sorghum*

	DM%	MM%	CP%	CF%
DM%	1			
MM%	0.467**	1		
CP%	0.198	-0.157	1	
CF%	0.110	0.523***	-0.542***	1

Ddl=24-2=22 α=0.1 rth=0.344 (*), α=0.05 rth=0.404 (**), α=0.01 rth=0.515(***)

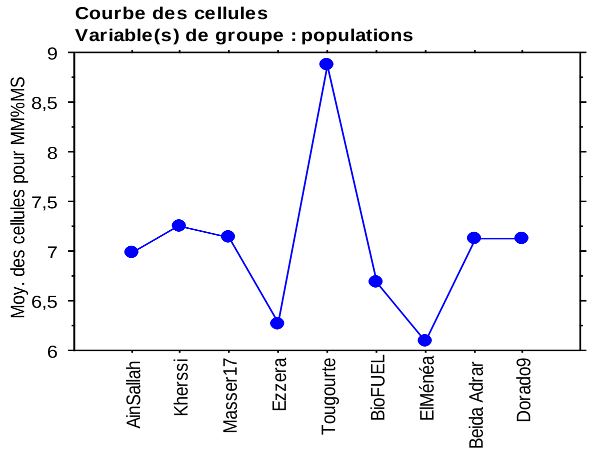


Figure 1. The average content of MM populations and varieties at milky-pasty stage

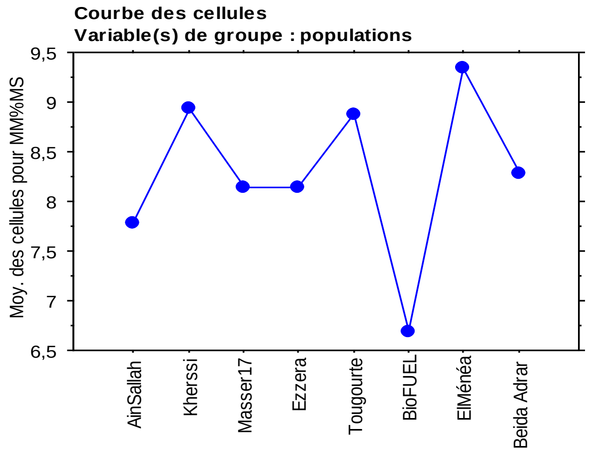


Figure 2. The average grade of MM populations and varieties at hard grain stage

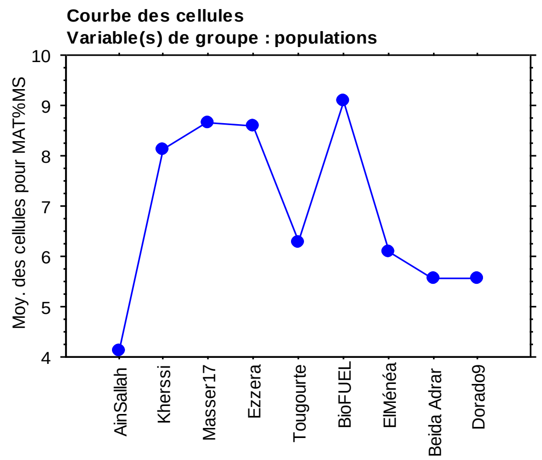


Figure 3. Population and variety counts in CP at milky-pasty stage

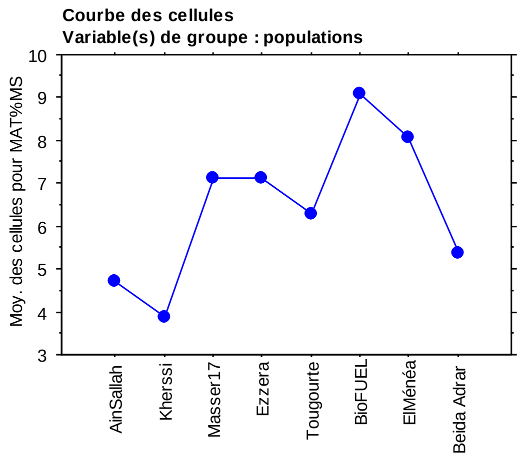


Figure 4. Population and variety counts in CP at hard grain stage

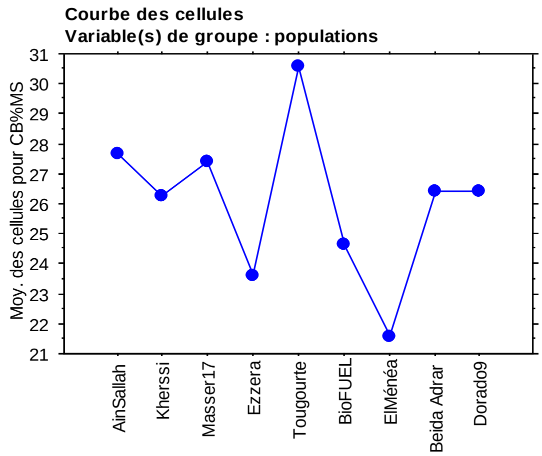


Figure 5. Populations and varieties counts in CF at milky-pasty stage

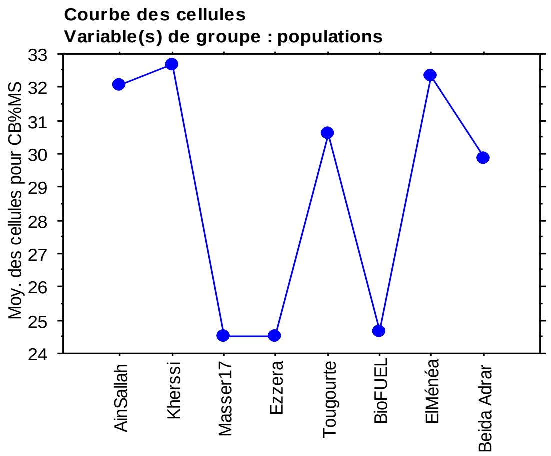


Figure 6. Populations and varieties counts in CF at hard grain stage

At the hard grain stage, according to Figure 6, the populations Ain Sallah, Kherssi, El Menea, and Tougourte recorded high levels in crude cellulose, but did not exceed 33%. All these populations are characterized by a long cycle greater than 100 days and a high to medium height, this rate of fiber is necessary to resist the lodging and the weight of the panicles.

In the analysis of the principal constituents at the milky-pasty stage and according to the Kaiser criterion (Figure 7), four axes can be chosen. In the elbow criterion, a significant fall is observed from the first axis (from 42.3% to 6.01% of the inertia). In the foreground (Figure 8) all the parameters are close to the circle, so they are indeed well correlated with the two factors constituting this plane (F1 and F2) except the parameter height which approaches the center it tends to cancel itself. The first factorial axis (1x2) gives (42,3% + 28,37% = 70,67%), the axis according to which is preserved, by the projection of the maximum of the initial dispersion of the points of the cloud. All variables occupy a restricted area within the correlation circle. The maximum angle between the two variables is less than 90 °. This suggests that all variables are positively correlated with each other.

The parameters, cycle in the day, MS%, ratio bark on the marrow, MM%, CF%, and height of the stems occupy the same plane and include the populations and varieties, El Menea, Tougourte, Dorado9, Ain Sallah. The opposite plane is occupied by the parameters CP %, and diameter of the stems group the rest of the populations which are Ezzera, Biofuel, Masser17, Beida Adrar, Kherssi.

At the hard grain stage, the Kaiser Criterion (Figure 9) can retain 3 axes. In the elbow criterion, there is a significant drop from the first axis (from 46.68% to 20.96% of the inertia). In the foreground (Figure 10), all the parameters are close to the circle, so they are indeed well correlated with the two factors constituting this plane (F1 and F2). The first factorial axis (1x2) gives (46.68% + 27.9% = 74.58%), is the axis according to which is preserved, by the projection of the maximum of the initial dispersion of the points of the cloud. All variables occupy a restricted area within the correlation circle. The maximum angle between the two variables is less than 90°. This suggests that all variables are positively correlated with each other**.** The parameters, cycle in the day, ratio bark on the marrow, MM%, CF% occupy the same plan and include populations and varieties, Kherssi, Beida Adrar, Tougourte, Ain Sallah. The opposite plane is occupied by the parameters CP%, and DM% regroup the rest of the populations which are Ezzera, Biofuel, Masser17, El Menea.

The results showed a greater diversity in the chemical composition of the stems than in those of the leaves. This diversity is much greater with the total walls than with the other variables. The average total wall (CF) content is lower in leaves than in stems and whole straw. This variation is explained by the fact that the leaves are richer in chlorophyllin parenchyma (hemicelluloses) which are more digestible walls, whereas the stems are rich in fibrous and little digestible support tissues. In addition, the varieties Masser 17, Ezzera, and Biofuel from milky-pasty stage to hard grain stage their cellulose rate to decrease. This can be explained by the decrease of the bark-to-marrow ratio of their stems, so at the hard grain stage, there has been a synthesis of parenchymal tissues at the central level of the stem. Also, these varieties are characterized by a short cycle and a short size. But for other populations (short and long cycles) there is an increase in the wall rate. The same result was obtained by Kondombo (2001) who noticed that the wall contents are higher in the early lines than in the later ones. Therefore, the authors who say that beyond the heading stage, the chemical composition, especially the cellulose content evolves (Andrieu and Weiss 1981, Demarquilly and Andreieu 1987) is not true in our case in all populations.

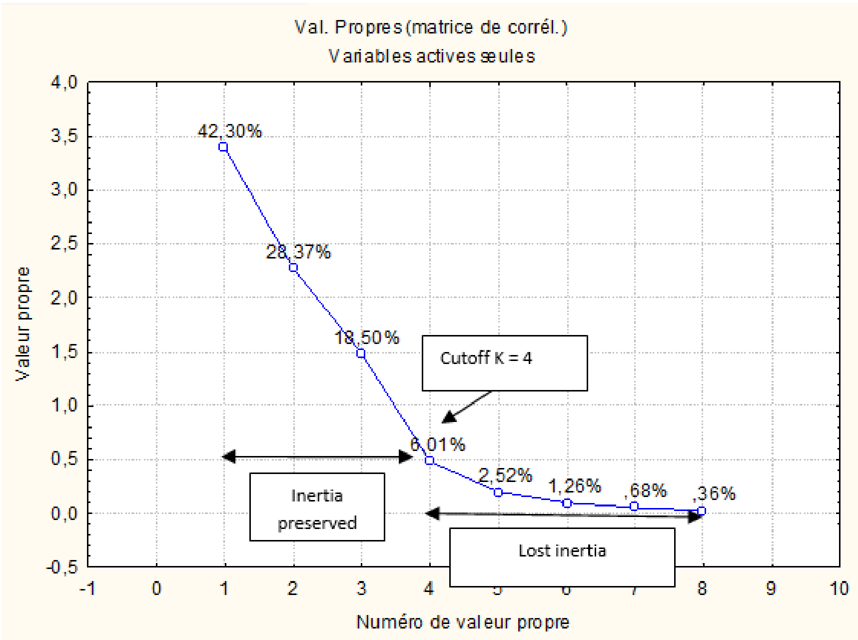


Figure 7. Graphical presentation of eigenvalues according to the Kaiser Criterion milky-pasty stage

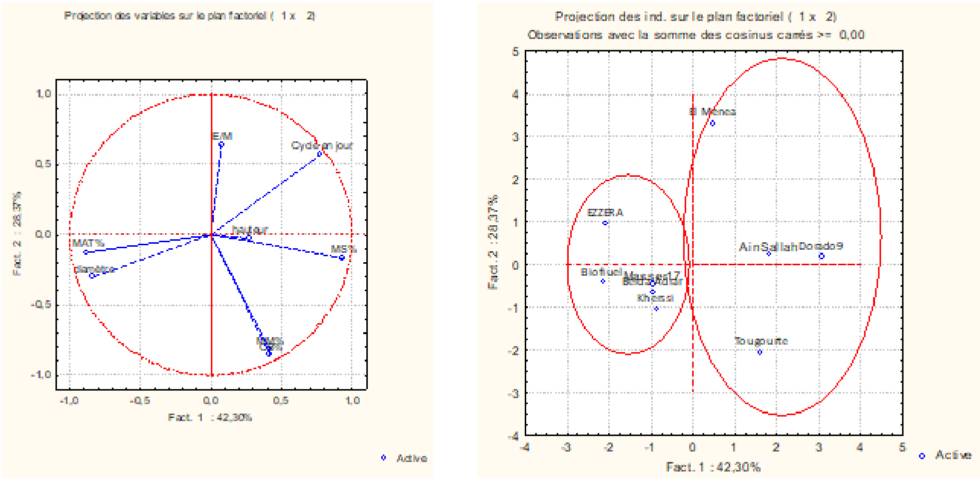
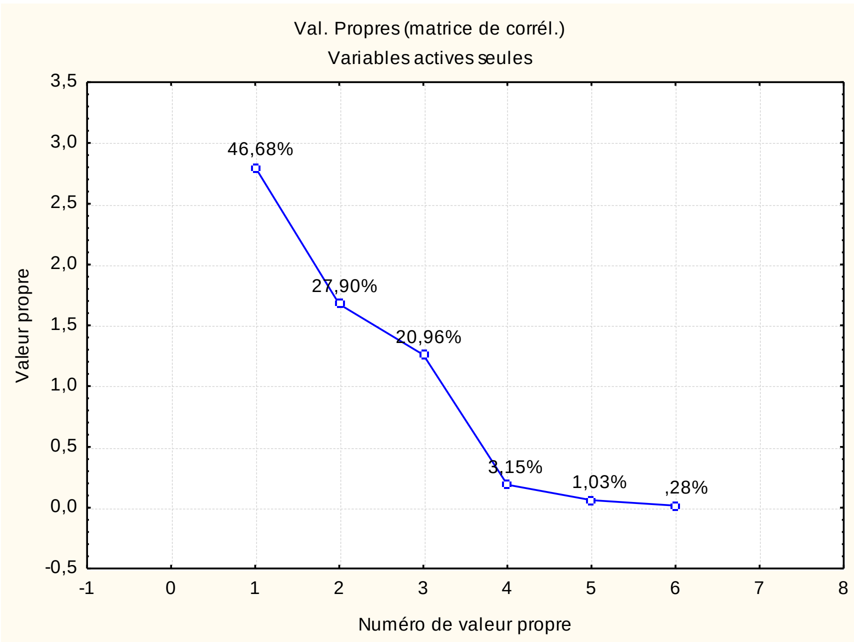


Figure 8. Analysis of the main components of the populations and varieties of sorghum studied according to plan1 at the milky-pasty stage



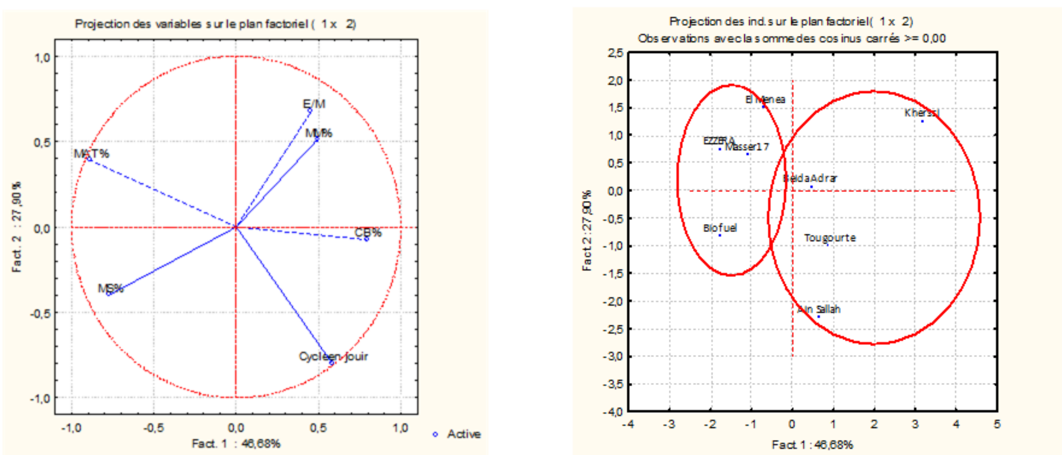


Figure 10. Analysis of the main components of the populations and varieties of *sorghum* studied according to plan1 at the hard grain stage

In this test, the average total nitrogenous matter (TMA) and total mineral contents are on average higher in the leaves than in the whole stems and straws. As for the whole straw, the different contents of the chemical composition and the values of digestibility, follow the evolution of those of the stems, because of their greater contribution to the total dry matter.

For the foraging aspect of the study, the analysis of the result leaves, stems, and straws whole, allowed to highlight the relations that exist between the main constituents and their influence on the food value of the straws. This analysis showed that many characters segregate independently. The use of fodder by animals is faced with the sorting problem, explaining that often the ingested values are higher than those distributed. The best populations and varieties for the content of CP, were: Khersi, Masser17, Ezzera, Biofuel at the milky-pasty stage. With El Menea, Ezzera, Biofuel, and Maser17 at the hard grain stage being the best for the content of CP. The low levels of cellulose in the milky-pasty stage are present in El Menea, Ezzera, and Biofuel whereas at the hard grain stage the low levels are at Biofuel, Ezzera, and Masser17.

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