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Genetic Diversity and Estimation of Heterosis of Sorghum (Sorghum Bicolor L. Moench) Varieties and their Hybrids for Grain Yield and other Traits at, Baoding, Hebei Province, China

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***Abstract* – Shortage of improved sorghum varieties was a challenge for the production of sorghum in China. Hence, the aim of the study was to exploit the genetic potential of sorghum varieties, to characterize the phenotypic traits, and estimate percentage of heterosis. Nine planting materials were laid out in randomized complete block design with three replications. Hybrid vigor was estimated by mid-parent and better- parent heterosis / heterobeltiosis methods. The ANOVA result indicated that, there was significant difference among the sorghum varieties and their hybrids, ($p < 0.05$). Grain yield varied from 2080.1 (GZ) to 5097.1 (RED1) kg/ha. RED1 had 8.40 % yield advantage over the parents, 623B and QS. Hundred seed weight varied from 2.07 (SLM) to 3.55 gram (White-1). The negative average heterosis for grain yield varied from -19.22 (White-1) to -0.76 (623A/RED2); heterobeltiosis ranged from -21.14 (White-1) to -2.30 (623A/RED2), implied hybrids were low yielders. Heterotic response for grain yield ranged -19.22 (White-1) to 8.40 (RED1); heterobeltiosis ranged -21.14 (White-1) to 5.55 (RED1). The average heterosis for hundred seeds weight varied from 5.4 (623A/ RED2) to 18.53 (White-1), heterobeltiosis ranged from 5.23 (623A/ RED2) to 18.53 (White - 1). Correlation was significant in all pairs of characters ($p < 0.05$). Grain yield positively correlated with days to maturity (0.064), head weight (0.323), and hundred seed weight (0.392*). Dendrogram confirmed, there was narrow genetic distance among testing materials. However, biplot of the principal component analysis (PCA) for sorghum traits revealed 60.16% variations. Based on the performance, at field condition, variation occurred among the tested sorghum varieties; therefore, we recommended the tested materials for future improvement of sorghum.**

***Keywords* – Sorghum, Heterobeltiosis, Heterosis, Traits.**

I. Introduction

Sorghum is the fifth most produced grain globally. It is the main staple cereal crop in many parts of arid and semi-arid regions of the world. Thus, essential crop in Africa, second to maize, as the major grain for millions of people [1].

The area currently planted to sorghum in China is stable at ~800,000 hm^2, and the total output is ~ 300 million tons/year [3].

Although sorghum can be used as food, feed, and as a construction material, it was used mainly for human food before the 1980s. Today, the majority of Chinese-produced sorghum is used to produce liquor and vinegar. Recently, China has imported large amounts of tannin free sorghum from America and other countries for use as animal feed, because the Chinese varieties have a high tannin content that is required for liquor flavor [2].

Sorghum is the first self-pollinated cereal staple crop, wherein heterosis has been commercially exploited due to the availability of a stable and heritable CMS system to improve its productivity. Considering the success of CMS-based hybrid technology in sorghum, continued investments have been made on sorghum hybrid parents and hybrid development research at ICRISAT-Patancheru, India. Hybrid parents' research at ICRISAT's regional hubs in Africa is still in its infancy, but is moving ahead [5]. The use of improved cultivars, particularly hybrids, was found to be the major component of the integrated approach of mitigating the drastic effect of drought [4].

Apart from hybrid parents, the sharing of appropriate genetic materials for conducting strategic research and the information on strategic research findings have helped improve sorghum improvement efficiency of both ICRISAT and NARS [5].

In the same manner to other potential countries, sorghum breeding in Ethiopia still not advanced using the existing genetically diverse sorghum resource. Particularly, application of Biotechnology in crop improvement is limited; hence further crop improvement using advanced breeding technology to be considered accordingly [6].

However, the application of heterosis in agricultural production yields multi-billion dollar returns and represents a single greatest applied achievement in the discipline of genetics. Hybrid rice technology has enabled China to increase its rice production significantly during the past 20 years.

Good hybrids have the potential for yielding 15% − 20% more than the best inbred variety grown under similar condition. Many reports led to the conclusion that there was significant occurrence of heterosis, which could be exploited commercially by developing F1 hybrids. Hybrid technology could offer great opportunity for increasing food production [7]. Hybrids sorghum had great contribution in the sorghum yield increase in the past 30 years. Hence, the aim of the study was to evaluate the parents' genetic diversity and estimate percentage of heterosis of their F1.

II. Materials and Method

2.1. *Field Experiment*

The field experiment was conducted at Qing Yuen research station at Baoding, China during the 2016 cropping season. The cropping history indicated, the field was sown maize a year ago.

2.2. *Description of Study Site*

Mean maximum and minimum temperatures were 14 ^{0}C and 4^{0}C, respectively. It receives a maximum of 550 mm rainfall per annum. The dominant soil types were fluvial-soil. Qing Yuen was the permanent experimental station of Agricultural University of Hebei. It lies between 115^{0} 34′ 39″ East longitudes and 38^{0} 47 ′ 16″ North latitudes. The land was leveled and good for farm machineries.

Table 1. Physio-chemical properties of the study area.

Parameter	Quantity
Organic matter	8.33g/kg
Total N	0.762g/kg
Available P	11.93mg/kg
Available K	81.90mg/kg
Soil PH	7.42

2.3. *Measured Parameters*

The agronomic characters evaluated under this study were days to emergence, days to flowering, days to maturity, aphid infestation, plant height (cm), leaf length (cm), leaf angle, leaf dropping angle, stand count at harvest, number of heads per plot, head weight (g), grain yield (g), hundred seed weight (g), disease and insect pests, aphid score (1-9 scale), where (3–Low susceptibility, 5-Medium susceptibility and 7-High susceptibility) in randomly taken plant samples.

2.4. *Experimental Design*

The treatments laid out in Randomized Complete Block Design (RCBD) with three replications. The plot size was 5m × 2m with 0.20m intra-row spacing and four row of 0.50m inter-row spacing. The Net plot size was 5m × 1.5m which is equivalent to 7.5m^2 whereas distance between the blocks was 0.50m. Therefore; the total experimental area was 16.0m× 22.0m which was 352.0m^2. Planting materials was conducted on May 28/2016. The sample plants were taken randomly from each plot per block and data recorded timely and properly.

2.5. *Statistical Analysis*

Analysis of variance (ANOVA) was carried out using SAS® 9.0 versions and XLSTAT 2014. F-test was used to test the significance differences between the genotypes, and least significance difference (LSD) for comparing the genotypic means at P ≤ 0.05. The sorghum varieties correlation was analyzed to determine the association of the traits that has been studied. The analysis was fitted in the mathematical model as presented below.

$$Y_{ij} = \mu + B_i + T_j + e_{ij} \quad (1)$$

Note:

Y_{ij} = Response corresponding to jth replication/block of the ith treatment.

μ = General effect

B_i = Block effect.

T_j = Treatment effect.

e_{ij} = Errors associated with jth replication/block of ith treatment.

Table 2. List of experimental materials with their merits.

Materials	Source	Special merit	Adaptation	Color
QS	China	Stay-green/ Aphid susceptible	Lowland	Red
HN16	China	Stay-green/ Aphid resistant	Lowland	White
H_2	China	Short plant height/ Stay- green	Lowland	Red
SLM	China	Late mature	Mid altitude	White
GZ	China/sweet farm	Stay-green/Early mature/ susceptible to aphid	Lowland	Red
623 B	America	Male sterile maintenance line/ most susceptible to aphid	Lowland	White
Red_1	China	Stay-green/early mature/heterotic	Lowland	Red
White-1	China	Stay-green/heterotic	Lowland	White
623A/RED_2	China	Stay-green/heterotic	Lowland	Light red

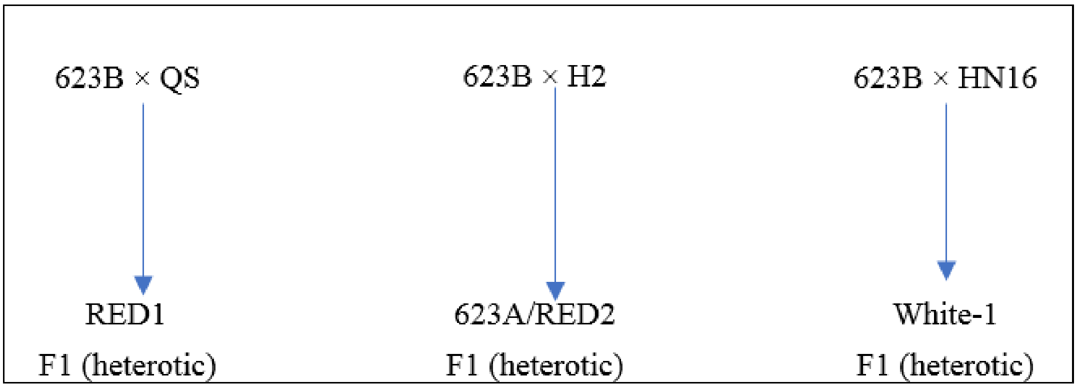

Fig. 1. Schematic representation of hybrids.

2.6. *Estimation of Heterosis in Sorghum*

The mid parent heterosis (MPH) and Heterobeltiosis, (BPH) were computed [7] as follows:

2.6.1. *Mid Parent Heterosis*

When the heterosis is estimated over the mid parent i.e. mean value of the two parents is known as mid parent heterosis. It is also known as average heterosis or relative heterosis and calculated by using the formula:

$$\text{Mid- Parent Heterosis} = \frac{\text{F1- MPH}}{\text{MPH}} \text{ X } 100 \qquad (2)$$

Where F1 is mean of F1 (the cross) and MP is mean of two parents Or, MPH= (F1-((P1+P2)/2) × 100 / (P1 + P2) /2.

2.6.2. *Better Parent Heterosis*

When the heterosis is estimated over the better parent is known as better parent heterosis. It is also known as heterobeltiosis and calculated by using the formula:

$$\text{Heterobeltiosis} = \frac{\text{F1- BPH}}{\text{BPH}} \text{ X } 100 \qquad (3)$$

Where BP is mean of better parents

Moreover the term heterobeltiosis was used by [8] to describe the improvement of heterozygote over the better parent of the cross.

Or it could be calculated as: Better-parent heterosis **(BPH) = (F1-BP) × 100 / BP**

III. Result

3.1. *Agronomic Traits*

The analysis result indicated that, there was significant difference among the sorghum genotypes of their chara- -cters studied at ($p < 0.05$ level), except for leaf length, leaf dropping angle, and number of heads per plots. Days to 50% flowering varied from 78 (RED1) to 91.33 (SLM) respectively. Grain yield varied from 2080.0 (GZ) to 5097.10 (RED1) kg/ha. Accordingly, the highest grain yield scorer varieties were RED1, HN16, H2,and 623A/RED$_2$ with grain yield 5097.10,5071.10,4984.20,and 4869.40 kg/ha respectively (Figure 2). Thus, hybrid varieties performed well over their parents.

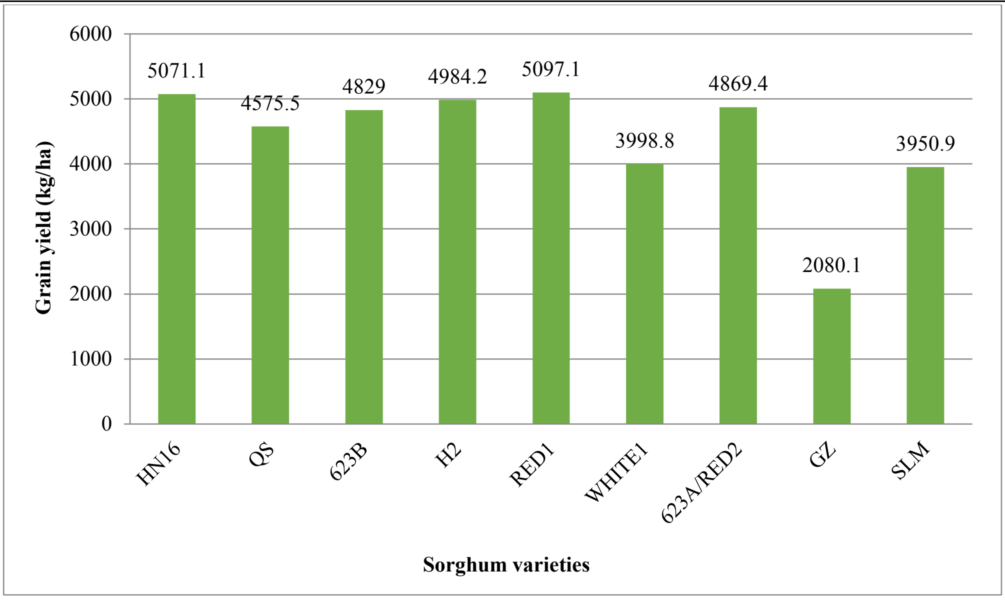

Fig. 2. Grain yield (kg/ha).

Table 3. Performances of sorghum varieties and their hybrids for agronomic traits and aphid resistance in the 2016 rainy season.

Materials	D50 F	Aphid	PH (cm)	LL (cm)	LA	LDA	DM	SCH	NHPP	HW (g)	GY(kg/ha^{-})	HSW(g)
HN16	89.0ab	1.00d	166.73cd	71.87a	43.53ab	1.24a	130.67b	35.33b	33.33a	97.79c	5071.1ab	2.93c
QS	80.33d	7.00a	173.30c	71.60a	36.6b	1.23a	122.33de	42.76ab	40.33a	106.73b	4575.5c	3.05c
623B	80.33d	2.33c	149.80e	75.73a	37.0b	1.37a	119.66e	39.67ab	37.0a	55.16g	4829b	3.06c
H_2	84c	1.00d	166.20cd	71.27a	49.4a	1.34a	124.66cd	34.0b	32.0a	76.99de	4984.2ab	3.05c
RED_1	78.0d	1.00d	182.07b	80.33a	33.93b	1.37a	126.67c	43.0ab	39.33a	78.81d	5097.1a	3.24b
$WHITE_1$	88b	1.00d	151.37e	76.0a	42.8ab	1.37a	131.67b	37.0ab	33.67a	73.41ef	3998.8d	3.55a
623A/RED_2	79.0d	4.33b	161.97d	68.8a	41.67ab	1.25a	122.33de	38.67ab	36.33a	159.2a	4869.4ab	3.22b
GZ	84.67c	4.33b	243.70a	76.73a	43.53ab	1.38a	119.33e	41.0ab	38.33a	69.62f	2080.1e	2.64d
SLM	91.33a	1.00d	249.77a	73.47a	40.33ab	1.35a	142.0a	46.66a	43.0a	32.11h	3950.9d	2.07e
Mean	83.85	2.556	182.77	73.98	40.97	1.32	126.59	39.78	36.89	83.31	4384.007	2.98
CV	1.87	26.08	2.76	15.48	17.04	6.79	1.71	16.43	17.31	3.46	2.96	2.87
LSD	2.71	1.15	8.74	19.82	12.09	0.15	3.75	11.32	11.05	5.00	224.65	0.15
R-Square	93.40	87.68	98.81	56.40	50.58	39.24	94.46	41.78	41.78	99.56	98.81	97.31

Means with the same letter in the same column are not significantly different at ($p < 0.05$) level.

D50F = Days to 50% flowering, Aphid = aphid infestation resistance recorded by (1-7 scale), PH = Plant height, LL = Leaf length, LA = Leaf angle, LDA = Leaf dropping angle, DM = Days to maturity, SCH = Stand count @ harvest, NHPP = Number of heads per plot, HW = Head weight, GY = Grain yield, HSW = Hundred seed weight.

RED1 had 8.40 % yield advantage over the parents, 623B and QS, hundred seed weight varied from 2.07 (SLM) to 3.55 gram (White-1) respectively. White-1 had 18.53 % hundred seed weight advantage over the parents, 623B and HN16. The result showed hybrid varieties performed better than their parents (Table 3). Head weight ranged from 159.20 (623A/RED$_2$) to 32.11 (SLM) gram respectively. 623A/RED2 had 141.03 % head/panicle/ weight advantage over the parents, 623B and H2 (Figure 3). Therefore, the heterotic variety 623A/RED$_2$ was better than its parents.

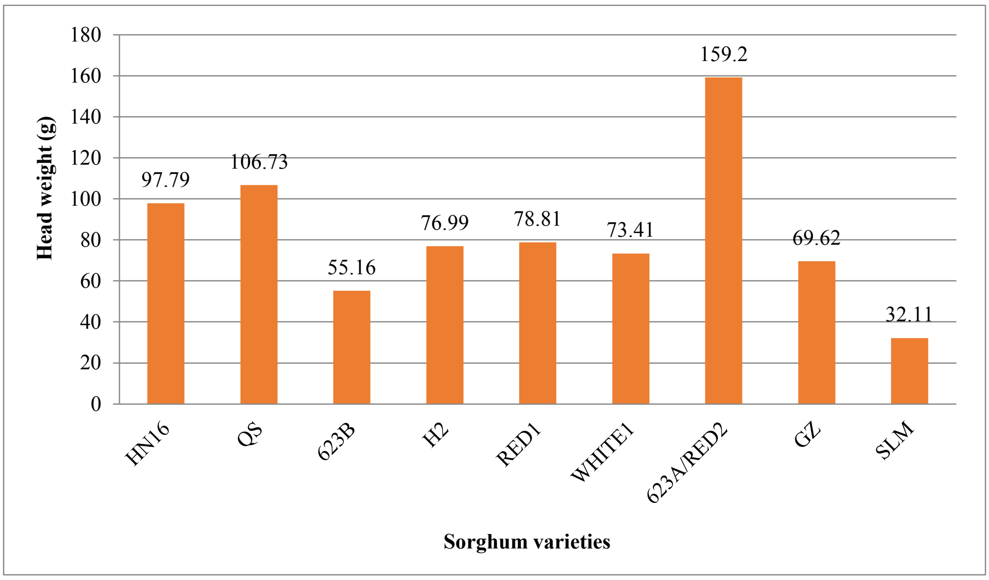

Fig. 3. Head weight (g).

The result revealed that the sorghum varieties HN16, RED$_1$, and White-1 were highly resistant to aphids (Figure 4). However, the sorghum variety QS was highly attacked (Table 3). The segregating ratio of resistant to susceptible plants in the F2 population was approximately 3:1. This indicates that a dominant gene primarily controls the resistance of sorghum plants to aphid infestation [9].

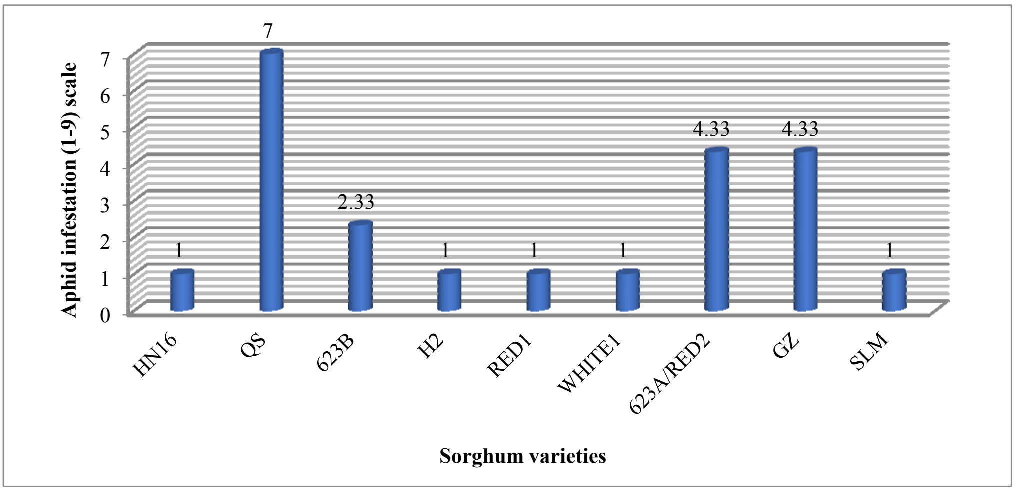

Fig. 4. Susceptibility to aphid infestation (1-9 scale).

Plant height ranged from 149.80 (623B) to 249.77 (SLM) cm respectively (Figure 5).White-1 and the parents showed difference statistically, unlike to practical or not that much significantly different at ($p < 0.05$) level. However, the hybrid 623A/RED$_2$ was shorter than its parents (Table 3). Therefore, the variety was good for modern farming system (mechanical cultivation).

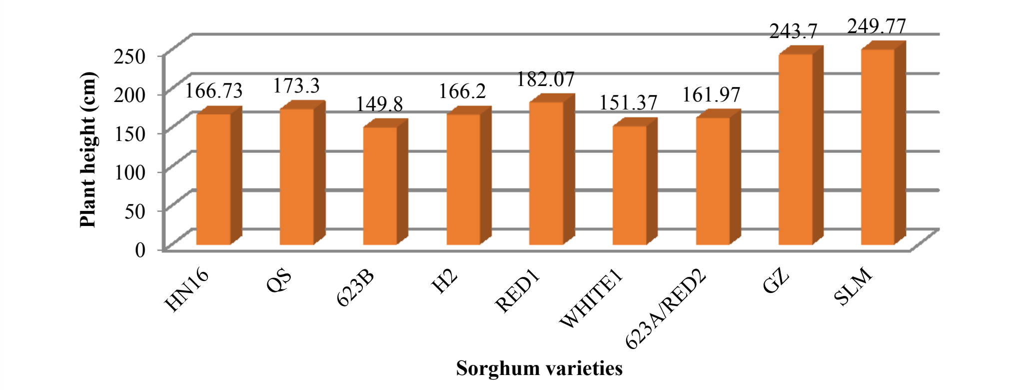

Fig. 5. Plant height (cm).

Due to the nature of sorghum varieties some are white in seed color and differs in seed size, paved way for attacking by birds. The crop was mostly vulnerable and damaged during milk to hard dough stage but invulnerable during vegetative growth. The damage was usually severe during maturation [10].

3.2. *Estimation of Heterosis*

The hybrids performed significantly better than the respective parents. Significant heterosis was observed for most of the studied characters. The result was similar with the work of [7]. Average heterosis and heterobeltiosis in hybrids varied significantly and could be due to genetic diversity of parents used to generate the hybrids. This indicated the existence of vigor and development of hybrids. Negative average heterosis for days to 50% flowering varied from -3.85 (623A/RED2) to -2.90 (RED1) whereas heterobeltiosis ranged between-5.95 (623A/RED2) and 1.12 (White-1). The result was similar with the findings of [16]. The most average heterosis and heterobeltiosis were expressed in 623A/RED$_2$. Hence, revealed that, this variety was an early maturing type (Table 4C:\Users\Z\AppData\Local\Temp\Performance of sorghum hybrids for estimation of heterosis\hybrid vigor\). This result is in agreement with the work of [11]. Plant height negative average heterosis was -4.35 (White-1) whereas heterobeltiosis ranged from -9.21 (White-1) to -2.55 (623A/RED2). The average heterosis for days to maturity varied from 0.14 (623A/RED2) to 5.20 (White-1). However, the average heterobeltiosis was -1.87 (623A/RED2) (Table 4.). The negative average heterosis for head (panicle) weight varied from -3.98 (White-1) to -2.61(RED1) whereas heterobeltiosis ranged -26.16 (RED1) and -24.93 (White-1). The negative average heterosis for grain yield varied from -19.22 (White-1) to -0.76 (623A/RED2) whereas heterobeltiosis ranged between -21.14 (White-1) and -2.30 (623A/RED2). This showed that these hybrids were low yielders. Heterotic response for grain yield ranged -19.22 (White-1) to 8.40 (RED1); however, heterobeltiosis ranged -21.14 (White-1) to 5.55 (RED1). The average heterosis for hundred seeds weight varied from 5.4 (623A/RED2) to 18.53 (White-1) whereas heterobeltiosis ranged from 5.23 (623A/RED2) to 16.01 (White-1) (Table 4C:\Users\Z\AppData\Local\Temp\Performance of sorghum hybrids for estimation of heterosis\hybrid vigor\).

Table 4. Performance of sorghum hybrids for estimation of heterosis/hybrid vigor.

Hybrids	D50% F		PH		DM		HW		GY		HSW	
	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH
RED$_1$	-2.90	-2.90	12.70	5.06	4.69	3.55	-2.61	-26.16	8.40	5.55	6.06	5.88
White-1	3.94	-1.12	-4.35	-9.21	5.20	0.77	-3.98	-24.93	-19.22	-21.14	18.53	16.01
623A/RED$_2$	-3.85	-5.95	2.51	-2.55	0.14	-1.87	141.03	106.78	-0.76	-2.30	5.4	5.23

Note:

MPH = Mid parent heterosis.

BPH = Better parent heterosis (Heterobeltiosis).

D50 F = Days to 50% flowering, PH = Plant height, DM = Days to maturity, HW = Head weight, GY = Grain yield.

HSW = Hundred seed weight.

3.3. *Correlations*

Correlation was significant in all pairs of characters ($p < 0.05$), except between days to 50% flowering and aphid infestation, head weight, and aphid infestation and grain yield, and leaf angle and aphid infestation (Table 5). The study revealed that stand count at harvest, number of heads per plot, and hundred seed weight have positive relationship with grain yield. The high positive and significant correlation value was obtained for panicle weight and hundred -seed weight with yield [12]. The yield was also positively and significantly associated with leaf length, leaf breadth, and number of leaves. Grain yield had positive genotypic correlation with most of the traits. Days to anthesis were negatively correlated with vegetative and reproductive traits [15].

Significant positive correlations between panicle width and grain yield (0.23**) and between seed weight and grain yield (0.22**) were observed [17].

Table 5. Correlation coefficient of quantitative traits.

	D50%F	API	PH	LL	DM	SCH	NHPP	HW	GY	HSW	LA	LDA
D50%F												
API	-.394*											
PH	.399*	-0.063										
LL	.027	-.188	.405*									
DM	.726**	-.565**	0.328	-.033								
SCH	0.018	-0.032	0.361	.289	0.159							
NHPP	0.002	0.011	0.311	.248	0.118	.977**						
HW	-.477*	0.29	-.454*	-.337	-.411*	-0.183	-0.135					
GY	-0.318	-0.122	-.695**	.587**	0.064	-0.14	-0.114	0.323				
HSW	-.492**	0.013	-.836**	-.079	-.435*	-0.316	-0.281	.492**	.392*			
LA	0.227	0.118	0.035	-.089	-0.011	0.074	0.15	0.019	-0.106	0.011		
NHPP	0.083	-0.252	0.273	.454*	0.088	-0.015	-0.052	-.425*	-0.274	-0.104	-0.301	

**Correlation is significant at the 0.01 level (two-tailed). *Correlation is significant at the 0.05 level (two-tailed).

3.4. *Cluster Analysis*

Sorghum varieties and their hybrids classified into six groups (Figure 6). The first group consisted of GZ, SLM; the second group contained WHITE 1, HN16; the third group consist WHITE 1, H2; the fourth cluster contain HN16, H2; however, there was small genetic distance between the second, third and the fourth group (Figure 6). Similar result was reported by [18]. The fifth group contain 623B, RED1; and the sixth cluster consist QS, 623A/RED2.

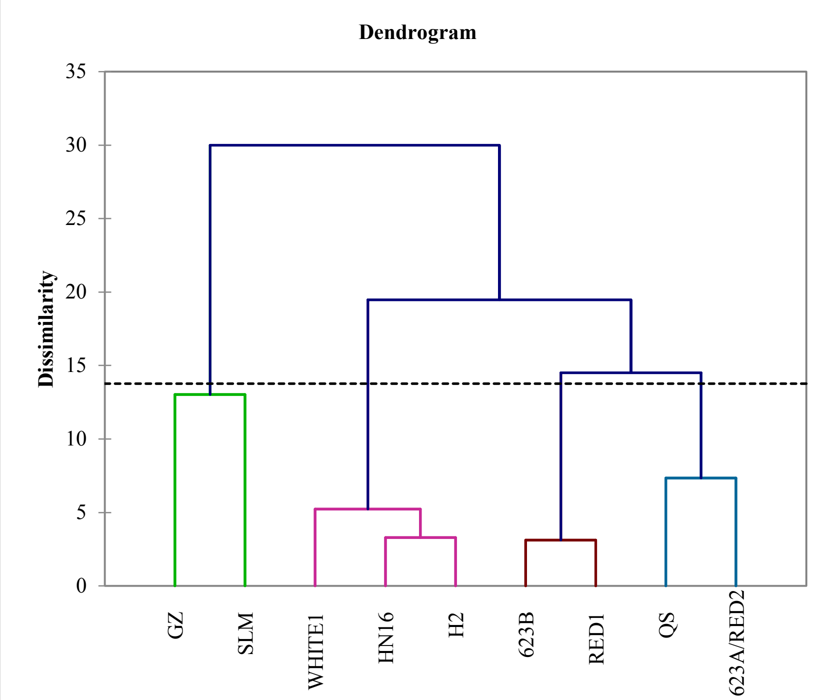

Fig. 6. Genetic similarity matrixes among sorghum varieties and their hybrids) revealed by Agglomerative Hierarchical Clustering (AHC) with XLSTAT based on morphological characters (phenotypic traits).

Biplot of the principal component analysis (PCA) for sorghum traits revealed 60.16% variations among sorghum varieties and their hybrids from the total variation (Figure 7).

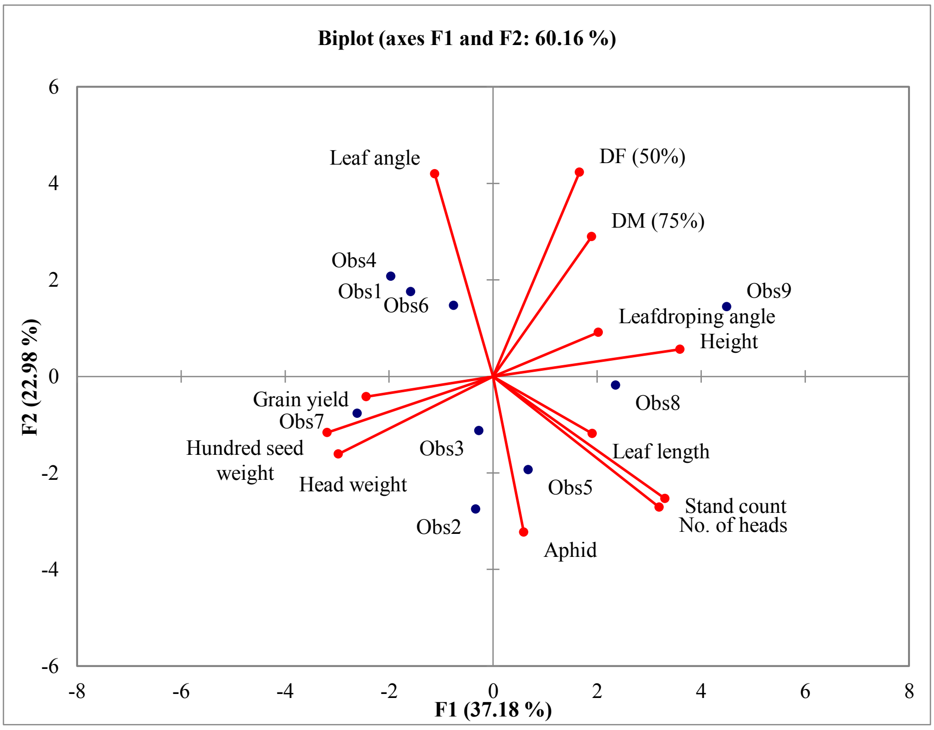

Fig. 7. Biplot of the principal component analysis (PCA) for sorghum traits in XLSTAT 2014.

IV. Conclusion

Based on the performance, at field condition, variation occurred among the tested sorghum varieties. Grain yield varied from 2080.1 (GZ) to 5097.1 (RED1) kg^{-1}. Since the demand for sorghum consumption, utilization, and processing increased so far, research and development work should be strengthened. Heterosis is an important component of hybrid yield performance. Identifying high yielding hybrids is expensive and involves testing large numbers of hybrid combinations in multi-environment trials [13]. Using improved varieties of sorghum could make an important contribution to increase agricultural production and productivity in areas like Kako where there is low practice of using improved technologies such as improved crop varieties [14]. Selection of good parents was found to be the most important for developing high yielding hybrid varieties [7]. Average heterosis and heterobeltiosis in hybrids varied significantly and could be due to genetic diversity of parents used to generate the hybrids, revealed existence of vigor and development of hybrids. Therefore, we recommended the tested materials for future improvement of sorghum.

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AUTHOR'S PROFILE

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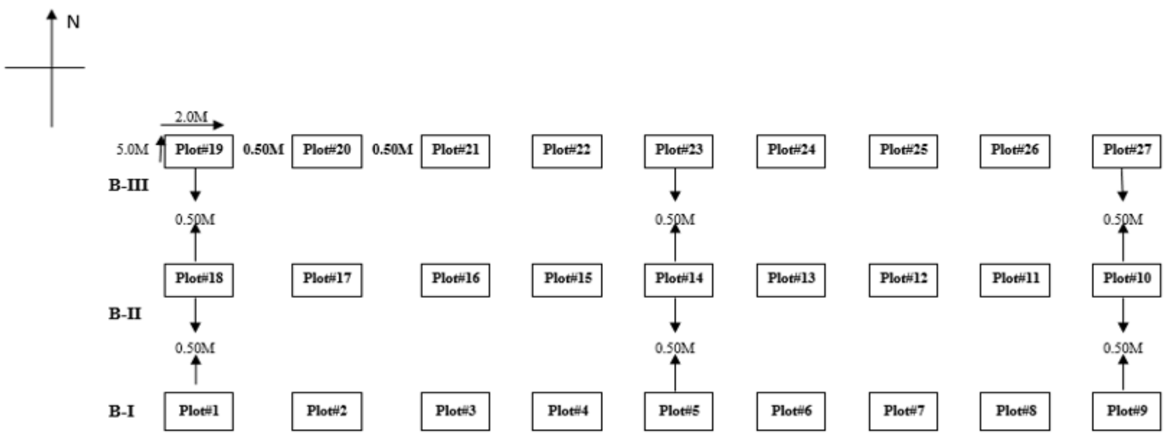
Field Layout: Qing Yuen Experimental Testing Sight, Baoding, 2016



Plot Size = 5.0M × 2.0M = 10.0M^2

Net plot size = 5.0M × 1.50M = 7.5M^2

Each Plot has 4.0 rows, only 2.0 are harvestable rows

Distance between rows = 0.50M = 50.0CM

Distance between plants (intra-row spacing) = 0.20M = 20.0CM

Distance between Plots = 0.50M = 50.0CM

Distance between Blocks = 0.50M = 50.0CM

Total Experimental Area = 16.0M × 22.0M = 352.0M^2

Agricultural Design = RCBD with three (3) replications

Sowing Date = 28/05/2016

Materials	Treatme-nt No.	Rep	Days to Flower-ing	Aphid infesta-tion	Plant height	Leaf length	Leaf angle	Leaf dropping angle	Days to Matu-rity	Stand count	No. of heads	Head wt.	Grain yield/ha	Hundred seeds wt.
QS	2	3	81	7	169.8	64.1	61.2	1.15	121	50	45	106.52	4428.1	3.02
623A/RED$_2$	7	3	79	5	158.6	66.2	46.6	1.17	122	32	28	152.61	4569.7	3.37
RED$_2$	4	3	86	1	176.4	67.2	52.6	1.35	127	31	27	75.87	4796.3	3.07
GZ	8	3	84	5	237.3	85.7	40	1.36	125	40	37	69.74	2088.6	2.54
623B	3	3	81	3	153.2	74	29	1.48	119	34	29	55.83	4683.2	3.06
RED$_1$	5	3	79	1	181.5	80.4	24.8	1.4	128		36	77.67	5129.8	3.24
SLM	9	3	90	1	243.8	72.8	43.2	1.37	143	50	45	32.45	3894.5	2.15
WHITE$_1$	6	3	91	1	153.7	81.8	44	1.28	133	44	41	73.95	3944.2	3.53
HN16	1	3	87	1	168.6	66.3	38.2	1.25	131	28	26	96.78	5131.3	2.95
RED$_1$	5	2	78	1	186.5	76.5	40	1.28	127	42	39	78.36	5136.9	3.09
GZ	8	2	86	3	245.2	79.2	34	1.46	117	33	30	70.41	2137.2	2.68
623A/RED$_2$	7	2	78	5	161.9	66.8	36	1.21	120	39	37	156.37	4985.1	3.12
HN16	1	2	91	1	164.4	67	37	1.32	132	36	34	98.67	4864.6	2.92
WHITE$_1$	6	2	88	1	147.6	72.6	38	1.32	132	32	30	73.92	3972.5	3.4
SLM	9	2	92	1	251.7	78.9	36.4	1.3	142	40	38	31.53	3929.4	2.01
RED$_2$	4	2	84	1	157.9	65.7	42	1.42	125	41	40	76.49	5119.7	3.04
623B	3	2	80	1	146.6	77.6	36.6	1.31	120	36	34	54.64	4787.4	3.01
QS	2	2	81	7	173.3	63.4	45	1.28	123	42	41	104.89	4565.3	3.05
HN16	1	1	89	1	167.2	64.6	55.4	1.15	129	42	40	97.94	5217.3	2.94
QS	2	1	79	7	176.8	58.2	58.4	1.26	123	36	35	108.78	4733.1	3.08
623B	3	1	80	3	149.6	70	45.4	1.25	120	49	48	55.02	5016.4	3.11
RED$_2$	4	1	82	1	164.3	58	53.6	1.25	122	30	29	78.63	5036.7	3.05
RED$_1$	5	1	77	1	178.2	84.2	37	1.43	125	45	43	80.41	5024.6	3.39
WHITE$_1$	6	1	85	1	152.8	73.8	46.4	1.41	130	35	33	72.36	4079.8	3.73
623A/RED$_2$	7	1	80	3	165.4	73.4	42.4	1.38	125	45	44	168.62	5053.3	3.18
GZ	8	1	84	5	248.6	91.8	56.6	1.32	116	50	48	68.72	2014.5	2.7
SLM	9	1	92	1	253.8	66.2	41.4	1.39	141	50	46	32.35	4028.7	2.07