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Genotypic variability in some sun flower (*Helianthus annuus* L.) hybrids evaluated in Khordunia under rainfed conditions

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Twenty locally generated hybrids of Sun flower (*Helianthus annuus* L.) hybrids were evaluated in two seasons (2012 and 2013) for yield and yield components at Khordunia area, Blue Nile State under rain fed conditions. A randomized complete block design with six replications was used for laying out the field experiments. The seeds were sown in the second and third week of July in the first and second seasons, respectively in plots 6 × 3 m^2. Each plot was divided into four ridges 70 cm apart and 6-m long. Three seeds were sown in holes of 20 cm distance along the ridge then thinned into one plant per hole three weeks after sowing. Weeding was practiced three times to control weeds. Rains were recorded during autumn at Khourdunia area. Fertilizers were not applied. The heads of the sample were bagged during the seed filling period using paper bags to avoid birds attack. Data were collected on the following characters: Days to 50% flowering, days to maturity, plant height, stem diameter, head diameter (cm), number of seeds/head, percentage of empty seed, 1000-seed weight (g), seed yield/plant (g) and seed yield (t/ha). Phenotypic, genotypic, and environmental variances were determined. The results in season 2012 revealed highly significant differences among the undertaken hybrids for plant height, stem diameter, head diameter, empty seed %, 1000-seed weight, seed yield/pant and seed yield (t/ha), whereas only two characters were significant in 2013. These were empty seed% and 1000-seed weight.

Key words: Sunflower, seed yield, genetic variability, genetic advance, heritability.

INTRODUCTION

The continuous demand for vegetable oils led to the interest in sunflower as a source of good quality oil. It ranks fourth among the world oil crops after palm oil, rapeseed, and soybean (Abdalla and Abdelnour, 2001). Sun flower (*Helianthus annuus* L.) which belongs to the family *Compositae* was rank the third largest source of oil

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Table 1. List of the sunflower hybrids used in the study.

S/N	Parent	Hybrid	Code	Origin
1	R1(Male)	Kh 99 X1	SHA1	UK
2	R5(Male)	Kh99X5 (Salih)*	SHA5	“
3	R6 (Male)	Kh99X6 (SHA 6)*	SHA6	“
4	R7(Male)	Kh 99 X7	SHA7	“
5	R11(Male)	Kh 99 X11	SHA11	“
6	R14(Male)	Kh 99 X13	SHA14	“
7	R15(Male)	Kh 99 X15	SHA15	“
8	R17 (Male)	Kh 99 X17	SHA17	“
9	R18 (Male)	Kh 99 X18	SHA18	“
10	R22 (Male)	Kh 99 X22	SHA22	“
11	R25-1(Male)	Kh 99 X25-1	SHA25-1	“
12	R25-2(Male)	Kh 99 X25-2	SHA25-2	“
13	R29(Male)	Kh 99 X29	SHA29	“
14	R30 (Male)	Kh 99 X30	SHA30	“
15	R32(Male)	Kh 99 X32	SHA32	“
16	R35(Male)	Kh 99 X35	SHA35	“
17	R37(Male)	Kh 99 X37	SHA37	“
18	R41(Male)	Kh 99 X41	SHA41	“
19	R42M(Male)	Kh 99 X42	SHA42-M	“
20	Hysun 33	-	-	Check

*Released recently as commercial varieties.

crops worldwide, following cotton seed and soybean. *H. annuus* is diploid (2n = 2X = 34. The main sunflower producing countries are former USSR, Argentina, France, USA, Romania, former Yugoslavia, Bulgaria, Spain and Turkey. According to FAO (1996), the cultivated area in 1996 all over the world was 21 million hectares, producing 2.5 million metric tons with an average seed yield of 1197 kg/ha. Reports by USDA (2000) noted that world sunflower seed production has increased from an average of 23.5 million tons in the mid 1990`s to 26.9 million tons in 2000.

Commercial production of sunflower in the Sudan was initiated in the 1987/1988 season, where 63,000 ha were grown under rain fed conditions by the private sector in Damazine. In the following season (1988/1989) the area was increased to 112,000 ha in Damazine and 34,000 ha in Gedarif State. The average yield was 1.5 t/ ha. Because of increasing demand for vegetable oil and to release more sesame seed and groundnut for export, much attention was focused recently on growing sunflower under the irrigated national schemes as a winter crop.

The climatic conditions and soil requirements for sunflower, generally, indicate that the central clay plain is potentially suitable for sunflower growing. Khidir (1997) reported that the most progressive varieties grown in Sudan are imported hybrids like Hysun 33, Sunbred 281, Tec 1560, Tec 1226, Northrubking, Pioneer 6480 and Dekaln G 100 and few open-pollinated ones, like Polareo, Rodeo and Hungaria. The economic importance of sunflower is the use of oil and seeds as human food, cake and shoot are used as animal feed. The inner pith of the stem is used for making fine writing paper. The plant is grown as an ornamental, a wind break in vegetable farms and for honey bee husbandry.

Sunflower is a highly cross-polinated crop, characterized by a high percentage of empty seed in open-pollinated and to a lesser extent in F1 hybrid varieties. In the present changing agriculture scenario and water constraint, area of sun flower production has been increased significantly since 2003. Sun flower hybrids produced contain 39 to 52% oil in the seeds and still have better yield potential (Anonymous, 2006).

The objective of this study is to estimate genetic variability in sunflower hybrids under rainfed conditions.

MATERIALS AND METHODS

Twenty hybrids of sun flower (*H. annuus* L.) were used to evaluate seed yield and its components in this crop for two consecutive seasons (2012 and 2013) in Khourdunia, Blue Nile State (11° 48′ N. Lat. and 34° 19′ E. Long.) under rain fed conditions. Rainfalls were recorded during autumn at Khourdunia (Table 2). The total rainfalls were 895 and 848.5 mm in the first and second seasons, respectively (Meteorology Authority, 2013). Nineteen of them were derived from crossing of nineteen locally generated restorer lines with one male sterile line (Kh99). Table 1 show the genetic materials used in this study. The seeds were provided by the Department of Agronomy, Faculty of Agriculture, University of Khartoum.

Table 2. Monthly rainfall (mm) during autumn seasons of 2012 and 2013 at Khordunia, Blue Nile State.

Month	2012	2013
May	20.0	48.5
June	80.0	59.0
July	180.0	255.0
August	405.0	236.5
September	200.0	168.5
October	10.0	81.0
Total	895.0	848.5

* Source: Damazine Agro-metrology Station, Blue Nile State.

Experimental design and data collection

A randomized complete block design with six replications was used to lay out the field experiments. The seeds of each hybrid were sown in plots 6 x 3 m^2 with four ridges 70 cm apart. Three seeds were sown in holes with spacing of 20 cm along the ridge then thinned into one plant per hole three weeks after sowing. Weeding was practiced three times to control the weeds, and fertilizers were not applied.

The sample plants were randomly selected from middle two ridges, and then their heads were covered during the period of seed filling using paper bags to avoid birds attack. Data were collected on plant height, days to 50% flowering, days to maturity, stem diameter, head diameter (cm), number of seeds/head, empty seed %, 1000-seed weight (g), seed yield/plant (g) and seed yield (t/ha).

Statistical analysis

The collected data were analyzed according to the standard statistical procedure described by Gomez and Gomez (1984). The estimates obtained from the individual analysis of variance were then used to compute the coefficient of variation (*CV%*) according to the formula:

$$CV\% = \sqrt{(EMS)}/G \times 100$$

where *EMS* is the error mean sum squares, *G* is grand mean, genotypic variance ($\delta_2 g$) which estimated as follows:

$$\delta_2 g = (M_2 - M_3)/r$$

where M_2, M_3 and *r* are the mean sum squares for genotype, error and number of replications, respectively, phenotypic variance ($\delta_2 ph$) which was calculated according to the following formula:

$$\delta_2 ph = \delta_2 g + \delta_2 e,$$

Environmental ($\delta_2 e$) variance was calculated as:

$$\delta_2 e = M_3,$$

Genotypic and phenotypic coefficient of variations (*GCV* and *PCV%*) which were calculated according to the formula of Burton and Devane (1953) as follows:

$$GCV\% = (\delta_2 g / G) \times 100$$

$$PVC\% = (\delta_2 ph / G) \times 100$$

where *G* is the grand mean, heritability estimate (h^2) in broad sense was estimated for each character according to the procedure of Johnson et al. (1955) as follows:

$$h^2 = (\delta_2 g / \delta_2 ph) \times 100$$

Genetic advance (*GA*) and genetic advance as percentage (*GA%*) of overall mean which were estimated using the formula of Robinson et al. (1949) as follows:

$$GA = k (\delta_2 g / \delta_2 ph)$$

$$GA\% = (GA/G) \times 100$$

where *G* is the grand mean, *k* is the selection differential (it equals 2.06 at 5% selection intensity) as defined by Lush (1943).

RESULTS AND DISCUSSION

Phenotypic and genotypic variability

Days to 50% flowering and days to maturity are characters that represent the reproductive stage. The vegetative stage represents plant height and stem diameter. These characters showed significant differences (P≤0.05) among the twenty sunflower hybrids in season 2012 and non-significant in season 2013. However, the hybrid SHA5 scored the best values for these characters in both seasons. Head diameter, empty seeds%, number of seeds/head, 1000-sedd weight and seed yield/plant represent the yield components. However, most of these characters revealed highly significant differences in both seasons. The hybrids SHA25-2, SHA29 and SHA30 gave the best values if not like to that of the check cultivar Hysun 33 (Tables 3 and 4). These findings are in agreement with those of Asifkhan et al. (2003), Rachid et al. (2004), Zannou et al. (2008), Izquierdo and Aguirrezabal (2008) and Mamta et al. (2017a) who stated significant differences among their respective materials. Moreover, Mamta et al. (2017a) who stated that day to 50% flowering was less affected by environmental conditions.

Table 3. Means of 10 characters of 20 sunflower hybrids evaluated at Khordunia in season 2012.

Hybrid	DF	DM	Pht (cm)	SD (cm)	HD (cm)	S/H	ES (%)	SW (g)	Y/P (g)	Yield (t/ha)
SHA 1	67.0^{abcde}	85.3^{abc}	75.2^{de}	0.89^{cd}	10.0^{bcd}	436^{a}	11.1^{abc}	33.8^{efg}	15.2^{def}	1.08^{ef}
SHA5	66.0^{e}	84.0^{c}	76.3^{cde}	0.99^{bc}	12.3^{bc}	564^{a}	11.7^{abc}	34.3^{defg}	16.4^{def}	1.17^{def}
SHA 6	66.7^{bcde}	85.3^{abc}	70.2^{e}	0.70^{d}	8.8^{d}	402^{a}	9.7^{bc}	35.4^{cdefg}	20.9^{cde}	1.49^{cde}
SHA 7	67.2^{abcde}	85.7^{abc}	77.8^{cde}	0.91^{cd}	12.5^{b}	585^{a}	8.0^{c}	36.1^{bcdef}	24.4^{bcd}	1.74^{cd}
SHA 11	66.2^{de}	84.0^{c}	86.8^{bcde}	1.30^{ab}	12.1^{bc}	455^{a}	12.3^{abc}	38.4^{abc}	18.1^{def}	1.21^{def}
SHA 13	68.0^{ab}	86.7^{ab}	89.4^{bcde}	1.19^{b}	12.5^{b}	523^{a}	14.5^{ab}	36.4^{bcde}	18.5^{def}	1.31^{def}
SHA15	68.3^{a}	86.7^{ab}	88.1^{bcde}	1.19^{b}	11.5^{b}	539^{a}	13.6^{abc}	36.4^{bcde}	22.6^{cde}	1.61^{cde}
SHA 17	67.3^{abcde}	85.7^{abc}	92.4^{bcd}	1.20^{b}	11.7^{bcd}	569^{a}	16.9^{a}	37.0^{bcd}	29.0^{bc}	2.07^{bc}
SHA 18	66.3^{cde}	84.7^{bc}	76.3^{cde}	1.01^{bc}	10.6^{bcd}	471^{a}	13.4^{abc}	38.6^{ab}	19.4^{def}	1.51^{cde}
SHA 22	67.2^{abcde}	85.3^{abc}	83.4^{bcde}	1.04^{bc}	12.6^{b}	527^{a}	14.3^{ab}	38.0^{abc}	23.4^{bcde}	1.65^{cde}
SHA 25-1	67.7^{abcd}	86.3^{ab}	84.7^{bcde}	1.00^{bc}	10.8^{bcd}	374^{a}	12.8^{abc}	30.9^{h}	13.9^{ef}	1.03^{ef}
SHA 25-2	67.8^{abc}	86.3^{ab}	96.0^{bc}	1.18^{b}	12.5^{a}	619^{a}	12.7^{abc}	40.4^{a}	13.4^{b}	2.43^{b}
SHA 29	67.0^{abcde}	85.3^{abc}	79.4^{cde}	1.01^{bc}	11.4^{bcd}	492^{a}	3.4^{d}	33.4^{fgh}	21.6^{cde}	1.58^{cde}
SHA 30	67.2^{abcde}	86.0^{abc}	100.5^{b}	1.24^{b}	12.2^{bc}	486^{a}	10.3^{bc}	36.9^{bcd}	11.3^{f}	0.79^{f}
SHA 32	66.7^{bcde}	85.3^{abc}	90.4^{bcd}	1.23^{b}	11.9^{bc}	545^{a}	9.7^{bc}	32.7^{gh}	14.8^{def}	1.06^{ef}
SHA 35	66.5^{bcde}	85.0^{bc}	79.8^{cde}	1.13^{bc}	11.5^{bcd}	521^{a}	16.4^{a}	36.2^{bcdef}	17.7^{def}	1.23^{def}
SHA 37	67.5^{abcde}	86.0^{abc}	90.5^{bcd}	1.30^{ab}	12.6^{b}	595^{a}	13.3^{abc}	38.8^{bcdef}	19.9^{def}	1.32^{def}
SHA 41	66.5^{bcde}	85.0^{bc}	78.7^{cde}	0.88^{cd}	9.3^{cd}	388^{a}	15.4^{ab}	36.8^{bcd}	15.0^{def}	1.08^{ef}
SHA42-m	66.8^{abcde}	85.7^{abc}	81.4^{bcde}	1.08^{bc}	9.7^{bcd}	479^{a}	14.3^{ab}	37.2^{bcd}	16.7^{def}	1.19^{def}
Hysun 33	68.3^{a}	87.3^{a}	12.47^{a}	1.49^{a}	16.6^{a}	683^{a}	10.4^{bc}	38.3^{abc}	53.7^{a}	3.62^{a}
Mean	67.1	85.6	86.1	1.10	11.7	513.0	12.2	36.1	21.2	1.51
CV (%)	1.8	1.8	16.3	23.5	19.5	38.9	34.7	6.1	32.6	35.0

* DF, DM, Pht., SD, HD, S/H, ES, SW and Y/P are days to flowering, days to maturity, plant height, stem diameter, head diameter, no. of seeds/head, empty seed, 1000-seed weight and seed yield/plant , respectively. ***** Any means having the same letter(s) are non-significantly different according to Duncan multiple range test at 5% level of significance.

Phenotypic, genotypic, and environmental variances

Estimation of phenotypic (δ^2_{ph}), genotypic (δ^2_g) and environmental variances (δ^2_e) indicate the genetic components background that reflects the divergent differences among the materials. In this study, phenotypic variances were greater than genotypic ones all characters in both seasons. The values of all variances for all characters in season 2013 were greater than their respective ones in season 2012. On the other hand, in season 2013, the phenotypic (δ^2_{ph}), genotypic (δ^2_g) and environmental (δ^2_e), variances were greater in characters, plant height, head diameter, number of seeds/head, empty seeds% and seed yield/plant, except in genotypic variance in characters empty seeds% and 1000-seeds weight (Table 5). Similar results were reported by Mahmood and Mehdi (2003), Arshad et al. (2007), Zannou et al. (2008), Izquierdo and Aguirrezabal (2008) and Fadlalla (2010) who reported that genotypic variances were smaller than their corresponding phenotypic one for all characters studied in sunflower. In contrast, Sajid (2004) showed that genotypic and phenotypic coefficient of variation was high for all seedling traits.

Phenotypic and genotypic coefficient of variations, heritability, and genetic advance

Estimates of phenotypic (PCV%) and genotypic (GCV%) coefficient of variations, heritability in abroad sense (h^2), genetic advance (GA) and genetic advance as percentage of the grand mean (GA%) for the first and second seasons are displayed in Table 6. In this study all the undertaken characters showed greater phenotypic coefficient of variations than their respective genotypic ones. These estimates were greater in season 2013 than those in 2012 for all characters, except for stem diameter, number of seeds/head, seed yield/plant and seed yield/ha. The highest PCV estimate was 52.72%. It was scored for seed yield/plant, while the lowest PCV% was 1.88%. It was scored by days to maturity in season 2012. However, in 2013 the highest PCV was 39.38 recorded for empty seeds, whereas the lowest was 3.33%, recorded for days to maturity. Regarding the heritability ($\boldsymbol{h^2}$) estimates, most of the characters had lower values (h^2<0.60) in both seasons, except seed yield/plant (g) in season 2012 (0.62). The highest h^2 estimate was 0.62 given by seed yield/plant (g), while the lowest $\boldsymbol{h^2}$ estimate was 0.01, given by number of seeds/head in season

Table 4. Means of 10 characters of 20 sunflower hybrids evaluated at Khordunia in season 2013.

Hybrid	DF	DM	Pht (cm)	SD (cm)	HD (cm)	S/H	ES (%)	SW (g)	Y/P (g)	Yield (t/ha)
SHA 1	59.5^{a}	93.8^{a}	86.4^{a}	1.12^{a}	12.3^{a}	450^{e}	20.6^{a}	59.4^{ab}	22.5^{a}	1.61^{a}
SHA5	57.3^{a}	92.7^{a}	121.6^{a}	1.40^{a}	16.8^{a}	790^{abc}	13.7^{abcd}	53.7^{ab}	33.4^{a}	2.38^{a}
SHA 6	57.7^{a}	92.7^{a}	106.9^{a}	1.05^{a}	11.9^{a}	454de	18.4^{abcd}	52.8^{ab}	21.8^{a}	1.56^{a}
SHA 7	58.0^{a}	91.8^{a}	107.7^{a}	1.03^{a}	12.0^{a}	697^{abcde}	20.4^{ab}	58.0^{ab}	27.6^{a}	1.98^{a}
SHA 11	57.3^{a}	93.7^{a}	130.3^{a}	1.58^{a}	15.0^{a}	831^{abc}	14.7^{abcd}	62.4^{ab}	37.7^{a}	2.70^{a}
SHA 13	60.3^{a}	93.5^{a}	131.0^{a}	1.64^{a}	17.5^{a}	807^{abc}	16.6^{abcd}	58.3^{ab}	38.1^{a}	2.72^{a}
SHA15	59.7^{a}	91.2^{a}	97.0^{a}	1.26^{a}	12.3^{a}	728^{abcde}	12.9^{abcd}	52.5^{b}	33.7^{a}	2.41^{a}
SHA 17	57.0^{a}	92.5^{a}	109.5^{a}	1.26^{a}	14.2^{a}	613^{bcde}	18.9^{abc}	62.8^{ab}	33.2^{a}	2.38^{a}
SHA 18	57.7^{a}	92.2^{a}	110.3^{a}	1.48^{a}	14.0^{a}	681^{abcde}	17.3^{abcd}	58.6^{ab}	33.0^{a}	2.36^{a}
SHA 22	58.8^{a}	95.2^{a}	119.7^{a}	1.42^{a}	15.2^{a}	622^{bcde}	15.8^{abcd}	56.3^{ab}	34.3^{a}	2.45^{a}
SHA 25-1	57.8^{a}	94.0^{a}	95.9^{a}	1.38^{a}	14.3^{a}	433^{e}	20.9^{a}	56.1^{ab}	20.1^{a}	1.44^{a}
SHA 25-2	60.5^{a}	93.5^{a}	102.1^{a}	1.35^{a}	14.8^{a}	870^{ab}	12.1^{bcd}	63.3^{a}	36.0^{a}	2.57^{a}
SHA 29	57.5^{a}	91.3^{a}	122.4^{a}	1.49^{a}	15.4^{a}	954^{a}	13.5^{abcd}	60.4^{ab}	40.5^{a}	2.89^{a}
SHA 30	58.8^{a}	92.8^{a}	138.3^{a}	1.39^{a}	14.0^{a}	708^{abcde}	10.5^{d}	55.8^{ab}	39.1^{a}	2.80^{a}
SHA 32	56.7^{a}	96.0^{a}	113.9^{a}	1.28^{a}	13.6^{a}	775^{abc}	14.0^{abcd}	59.4^{ab}	35.0^{a}	2.50^{a}
SHA 35	58.2^{a}	90.7^{a}	119.8^{a}	1.32^{a}	14.3^{a}	655^{abcde}	18.7^{abcd}	60.4^{ab}	31.0^{a}	2.21^{a}
SHA 37	57.7^{a}	91.8^{a}	120.8^{a}	1.42^{a}	13.8^{a}	640^{abcde}	14.2^{abcd}	52.2^{b}	32.3^{a}	2.31^{a}
SHA 41	57.2^{a}	92.5^{a}	111.0^{a}	1.57^{a}	14.9^{a}	523^{cde}	17.6^{abcd}	61.9^{ab}	25.2^{a}	1.80^{a}
SHA42-m	57.5^{a}	93.3^{a}	88.5^{a}	1.21^{a}	11.5^{a}	765^{abcd}	11.2^{cd}	62.4^{ab}	34.5^{a}	2.47^{a}
Hysun 33	60.3^{a}	94.0^{a}	107.3^{a}	1.40^{a}	14.6^{a}	589^{bcde}	14.5^{abcd}	57.0^{ab}	28.9^{a}	2.07^{a}
Mean	58.3	93.0	112.0	1.35	14.1	679.0	15.80	58.2	31.9	2.28
CV (%)	4.1	3.3	23.9	26.0	22.6	33.2	37.1	13.0	37.1	37.2

* DF, DM, Pht., SD, HD, S/H, ES, SW and Y/P are days to flowering, days to maturity, plant height, stem diameter, head diameter, no. of seeds/head, empty seed, 1000-seed weight and seed yield/plant, respectively. ***** Any means have the same letter(s) are non-significantly different according to Duncan multiple range test at 5% level of significance.

Table 5. Phenotypic (δ^2_{ph}), genotypic (δ^2_g), and environmental (δ^2_e) variances for 10 characters of 20 sunflower hybrids evaluated at Khordunia for two seasons 2012 and 2013.

Character	Season 2012			Season 2013		
	(δ^2Ph)	(δ^2g)	(δ^2e)	(δ^2Ph)	(δ^2g)	(δ^2e)
Days to 50% flow	1.73	0.21	1.51	6.13	0.50	5.63
Days to maturity	2.60	0.35	2.25	9.57	0.18	9.39
Plant height (cm)	305.60	108.89	196.67	787.10	73.58	713.52
Stem diameter	0.09	0.02	0.07	0.13	0.01	0.12
Head diameter (cm)	7.08	1.91	5.17	11.00	0.82	10.18
No. of seed / head	40316	566	39751	62864	12070	50793
Empty seed (%)	24.68	6.75	17.92	38.82	4.35	34.47
1000-seed weight (g)	9.18	4.28	4.90	66.79	9.55	57.24
Seed yield/plant (g)	124.80	77.14	47.65	151.18	10.70	140.48
Seed yield (t/ha)	0.62	0.35	0.28	0.77	0.05	0.72

2012. However, in season 2013, the highest was 0.19, given by number of seeds/head, while the lowest one was 0.02 given by days to maturity (Table 8). Like the trend of the heritability estimate, the values of the expected genetic advance under selection (GA%) changed over seasons. GA% value scored for seed yield/plant (g) was 52.78% as highest score in 2012, but it scored 1.49% in 2013, respectively. The highest estimate of GA% was 6.40%. It was recorded for number of seeds/hesd, whereas the lowest one 0.02% and scored by days to maturity in 2013 (Table 8). The rest of the characters showed low and staple values in the

Table 6. The phenotypic (PCV %), genotypic (GCV %) coefficient of variations, heritability (h2) estimates, genetic advance (GA) and genetic advance as percentage of the mean (GA%)in 10 characters of 20 sun flower hybrids evaluated at Khordunia for two seasons 2012 and 2013.

Characters	Season 2012					Season 2013				
	PCV (%)	GCV (%)	h^2	GA	GA (%)	PCV (%)	GCV (%)	h^2	GA	GA (%)
Days to 50% flowering	1.96	0.68	0.12	0.12	0.17	4.25	1.21	0.08	0.12	0.20
Days to maturity	1.88	0.69	0.13	0.16	0.19	3.33	0.46	0.02	0.02	0.02
Plant height (cm)	20.31	12.12	0.38	7.66	8.90	25.15	7.66	0.09	1.65	1.47
Stem diameter	27.18	13.58	0.25	0.08	6.98	26.73	6.15	0.05	0.01	0.67
Head diameter (cm)	22.85	11.88	0.27	0.77	6.62	23.50	6.40	0.07	0.14	0.98
No. of seed / head	39.17	4.64	0.01	0.69	0.13	36.91	16.18	0.19	43.46	6.40
Empty seed (%)	4.66	21.27	0.27	1.47	11.99	39.38	13.18	0.11	0.48	3.04
1000-seed weight (g)	8.38	5.72	0.47	1.98	5.49	14.05	5.31	0.14	0.91	1.56
Seed yield/plant (g)	52.72	41.45	0.62	11.18	52.78	38.53	10.25	0.07	0.48	1.49
Seed yield (t/ha)	52.40	39.03	0.55	0.67	44.62	38.53	10.23	0.07	0.03	1.48

different seasons. In agreement, Mamta et al. (2017b) stated that PVC was slightly high than GCV in sunflower hybrids. They also reported that heritability was high for seed yield/plant. Similar results were reported by Farooq et al. (2006) and Fadlalla (2010). On the other hand, Monica and Lauren (2003) expressed that heritability was lower in inbreeding species. Similar results for genetic advance were reported by Mamta et al. (2017a) who stated that genetic advance as percent from mean was high for seed yield/plant followed by seed weight.

Conclusion

From the results of this study it concluded that there were significant differences among the undertaken hybrids. The phenotypic coefficients of variation values were greater than their corresponding genotypic ones. Heritability values were low for all characters, except for seed yield/plant. Genetic advance as percentage from the overall mean values were greater in 2012 than their corresponding ones in 2013. More investigation should be done for some promising hybrids. They were SHA258-2, SHA29 and SHA30.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

Abdalla AA, Abdelnour O (2001). The Agricultural Potential of Sudan Exclusive Intelligence Review. pp. 27-45.

Anonymous (2006). Agricultural statistic of Pakistan Ministry of food, Agriculture and live stock (2005/06), Govt. of Pakistan, Islam bad P 65.

Arshad MM, Kashif I, Ayub Khan M (2007). Genetic divergence and path coefficient analysis for seed yield traits in sunflower (*Helianthus annuus* L.) hybrids. Pak. J. Botany 39(6):2009-2015.

Asifkhan I, U11ah S, Murtaza B, Khan MY (2003). Variability and correlation Study in different newly developed sunflower hybrids. Nat. Agric. Res. Center Asian J. Plant Sci. 2(12):887-890.

Burton GW, Devane EM (1953). Estimating heritability in tall Fescue (*Fescue arandiacae* L.) from replicated colonial material. Agron. J. 45:478-481.

Fadlalla MEK (2010). Evaluation of some Sunflower (*Helianthus annuus* L.) Hybrids under Rainfed Conditions. Ph. D. Thesis, Omdurman Islamic University, Sudan.

Farooq AK, Sajid AA, Shakeel AS, Ghulam A (2006). Genetic variability and genetic advance analysis for some morphological traits in *Brassica napus* L. J. Agric. Res. 44(2).

FAO (1996). Food and Agricultural Organization of the United Nation Production Year book, Vol. 50.

Gomez KA, Gomez AA (1984). *Statistical procedures for Agricultural Research*. 2nd. John Wiley and sons, Inc. New York.

Izquierdo NG, Aguirreabal LAN (2008). Genetic variability in the response of fatty acid composition to minimum night temperature during grain filling in sunflower. Argentina Field Crops Res. 106(2):116-125.

Johnson HW, Robinson HE, Comstock RE (1955). Estimates of genetics and environmental variability in soybean. Agron. J. 47:314-318.

Khidir MO (1997). Oil Crops in Sudan. U. of K. press/sited. pp 103 – 120.

Lush JL (1943). Animal Breeding Plans, Iowa Ames: the collegiate press. Ed.3.

Mahmood T, Mehdi SS (2003). Evaluation of S_1 and S_2 progenies of sunflower (*Helianthus annuus* L.) for seed yield, its components and resistance to plant Charcoal rot (*Macrophomina phaseolina*). Asian J. Plant Sci. 2(11):834-840.

Mamta R, Sheoran OP, Sheoran RK, Jambholkar S, Subhash C (2017a). Studies on genetic variability and interrelationship of seed yield and quality traits in germplasm collection of sunflower (*Helianthus annuus* L.). *Ann. Biol.* 33(1):82–85.

Mamta R, Sheoran OP, Sheoran RK, Subhash C (2017b). Genetic variability, character association and path analysis for agronomic traits in sunflower (*Helianthus annuus* L.). Ann. Agric. Bio. Res. 22(1):82-85.

Meteorology Authority (2013). Metrology Authority, Repots of Damazine Agro-metrology Station 2005/06, Blue Nile State.
Monica AG, Lauren RG (2003). *Inheritance and Natural Selection on Functional Trait*. Int. J. plant Sci. 164 (3 suppl.):s21-s42.
Rachid G, Alchaarami L, Centzbittel X, Huang Q, Sarrafi A (2004). Variation and genotypic identification of QTLS of sunflower (*Helianthus annuus* L.). Theor. Appl. Genet. 109(7):1353-1360.
Robinson HF, Comstock RE, Garvez PH (1949). Estimation of heritability and degree of dominance in Corn. Agron. J. 41:335-359.
Sajid H (2004). Genetic variation of seedling traits in a random mating population of sunflower. Pak. J. Agric. Res. 18:1.
USDA (2000). The Colombia Electronic Encyclopedia Sixth Edition. Colombia. Pres. Licensed from Colombia Univ. Press.
Zannou ADK; Kossou A, Ahanchede J, Zoundjihekpon E, Agbicodo P, Struik C, Sanni A (2008). Genetic variability of cultivated Cow-pea in Benin assessed by random amplified polymorphic DNA. Benin. Afr. J. Biotechnol. 7(24):4407-4414.