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# Genotype x season interaction and characters association in some sesame (*Sesamum indicum* L.) genotypes under rainfed conditions of Sudan

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## ABSTRACT

An experiment was carried out at Gedaref Agricultural Research Station, Sudan, during the rainy seasons 2008/09 and 09/2010 to estimate the genotype x season (GxS) interaction and to determine the characters association for seven sesame genotypes. A randomized complete block design with four replicates was used. Data were collected on days to 50% flowering, days to maturity, plant height, number of capsules/plant, seed yield/plant and seed yield/ ha. All characters showed highly significant differences at the genotypic level. The days to 50% flowering and to maturity revealed significant differences in both seasons and the G x S interaction, whereas the seed yield / plant showed significant differences between seasons. Gedaref -1 exceeded the overall mean of seed yield by 26.15%. In both seasons, days to maturity, plant height, number of capsules/plant, seed yield/plant were significantly and positively correlated at both the genotypic and the phenotypic levels with seed yield /ha and among themselves. It is concluded that sesame yield is highly influenced by the season, and to improve its yield, emphasis should be made on selection of early maturing tall plants with more capsules and higher seed yield/plant.

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## INTRODUCTION

Sesame (*Sesamum indicum* L.), a diploid species (2n=26), is a member of the family Pedaliaceae; known as beniseed, gingelly, sim-sim and til. It is grown throughout the tropics and sub-tropics from latitude 25º N to 25ºS (Ashri, 1998). The origin of sesame is Africa, and from there it spread through West Africa to India, China and Japan which became secondary distribution centers (Ramanathan, 2004). However, Bedigian (2003) and Bedigian and Harlan (1986) reported that the crop was originated in India.

Sesame is one of the most important oilseed crops in Sudan, both for local consumption and for export (Ahmed, 2008). It is widely grown in the Sudan under rainfed conditions, and ranks third in area after sorghum and millet. In 2008, the world production was about 3,603,006 tons produced from 7,534,201 ha. Large producers are India (666,000 ton), Myanmar (620,000 ton), China (586,408 ton) and Sudan (350,000 ton), covering about 61.7 % of the total world production (FAOSTAT, 2009).

The phenotypic performance of a genotype is influenced by its genetic, environmental factors and their interactions. The detection of a significant genotype x environment interaction indicates that all phenotypic responses to changes in the environment are not the same for all genotypes. This may mean that the best genotype in one environment is not the best in an another. Significant genotype by environment interaction for characters, like days to 50% flowering, days to maturity, plant height, number of branches and seeds per plant, 1000-seed weight and yield in sesame, were detected by many researchers (Perkins and Jinks, 1968; John and Nair, 1993).

Correlation coefficient is a statistical measure, which is used to find out the degree and direction of relationship between two or more variables. In plant breeding, the correlation coefficient measures the mutual relationship between various characters and determines the component on which selection can be based for genetic improvement in yield (Singh and Narayanan, 1993).

Positive and significant correlation coefficients between the various pairs of characters, e.g. yield, yield components and other morphological traits in sesame at the phenotypic and the genotypic levels, were reported by many workers (Chaudhary *et al.*,1977; Dhamu *et al.*,1983; Kandasamy *et al.*, 1990). On the other hand, plant height, number of branches and capsules had a negative association with seeds per capsule (Reddy, 1986).

The objectives of this study were to determine the interaction of G x S and to asses the characters association for some morphological traits, seed yield and its components in seven sesame genotypes under rain-fed conditions of the Sudan.

## MATERIALS AND METHODS

The study was carried out at Gedaref State, which is located in the eastern part of the Sudan (lat. 14º 24' N, long. 35º 45 ' E, elevation 592 masl). The soil is classified as vertisol, dark heavy cracking clay (75%), with low organic matter and low nitrogen content (Blokhuis, 1993). The climate is semi-arid, rainfall is 300-500 mm in the northern Gedaref and 600-900 mm in the southern Gedaref. Mean temperature is 20º C in winter and 40º C in summer.

The field experiment was conducted for two consecutive seasons (2008/ 09 and 2009/ 10) at the Sesame Research Center Farm of the Agricultural Research Corporation, Sudan. In each season, a randomized complete block design with four replicates was used. Each block was divided into 7 plots, to which the genotypes were assigned randomly. The plot size was 2.4 x 5.0 m. Each genotype was represented by four rows, each 5 m long and 0.6 m apart. Seven sesame genotypes; namely, Ziraa-9, Kenana-2, Khidir, Um shagara, Promo, SPS2003T10, and Gadaref-1, were used . The seeds were sown manually in furrows along the row. Sowing date was 18 and 14 of July in the first and the second seasons, respectively. The plants were thinned to 24 plants/m$^2$, three weeks after sowing. The experimental area was kept free of weeds and pests infestation in both seasons. Nitrogen fertilizer in the form of urea was applied at the rate of 80 kg /ha. Data were collected on the following parameters: Days to 50% flowering, days to maturity, plant height, number of capsules /plant, seed yield /plant and seed yield (kg/ha).

The data were subjected to the combined analysis of variance to estimate the variance of genotypes x seasons interaction, according to the standard statistical procedure described by Gomez and Gomez (1984). Duncan's multiple range test was used to compare treatment means. The phenotypic and genotypic correlations between all possible pairs of different characters were estimated, according to the formula of Miller *et al*. (1958) as follows:

Genotypic correlation coefficient: $= \frac{\sigma g_{1.2}}{\sqrt{(\sigma^2 g_1)(\sigma^2 g_2)}}$

Phenotypic correlation coefficient: $= \frac{\sigma ph_{1.2}}{\sqrt{(\sigma^2 ph_1)(\sigma^2 ph_2)}}$

where: $\sigma g_{1.2}$ = genotypic covariance between two characters $x_1$ and $x_2$.

$\sigma^2 g_1$ and $\sigma^2 g_2$ = genotypic variance for characters $x_1$ and $x_2$.

$\sigma ph_{1.2}$ =phenotypic covariance between two characters $x_1$ and $x_2$.

$\sigma^2 ph_1$ and $\sigma^2 ph_2$ =phenotypic variance for characters $x_1$ and $x_2$.

## RESULTS AND DISCUSSION

The combined analysis of variance revealed highly significant (P= 0.001) differences for all characters at the genotype level (Table 1). Days to maturity was highly significant (P≤ 0.001) at season and genotype levels, whereas number of days to flowering was highly significant (P≤0.001) at the season level and significant (P≤0.05) at the season x genotype level. Seed yield/plant was significant at the season level.

The significant interaction for the above mentioned characters suggests that the ranking of the genotypes for these characters was not constant over the seasons. The size of the interaction components, relative to that of the genetic component, is important because it directs breeders to the most likely area of adaptation of a successful cultivar. If the interaction is large relative to the genotypic ones, the breeder would search for a genotype to meet the specific requirements of that environment. The significant interaction for yield/plant and related traits in this study confirms the findings of Perkins and Jinks (1968) John and Nair (1993) and Solanki and Gupta, (2000) who reported significant interactions for yield and its components with season in sesame. On the other hand, plant height, number of capsules / plant and seed yield (t/ha) showed non- significant interaction at both season and season x genotype levels (Table 1).

**Table 1. Mean squares for genotypes, season and their interaction of 6 characters in 7 sesame genotypes.**

| Characters | Genotype | Season | Season x genotype |
|---|---|---|---|
| Days to 50% flowering | 84.056*** | 300.858*** | 2.382* |
| Days to maturity | 79.956*** | 514.251*** | 9.531*** |
| Plant height (cm) | 2306.25*** | 0.161 | 135.036 |
| Number of capsules/plant | 442.506*** | 48.286 | 130.824 |
| Seed yield/plant (g) | 8.074*** | 7.49* | 3.662 |
| Seed yield (kg/ha) | 71235.988*** | 35050.018 | 15650.893 |

*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels, respectively.

The earliest genotype was SPS2003T10 (77.80 days), whereas the latest one was Gedaref-1 (87.10 days) (Table 2a). The highest yielding genotype was Gedref- 1 ( 591.00 kg/ha), and the lowest yielding was Ziraa - 9 (361.00 kg/ha) (Table 2 b). Gedaref-1 exceeded the overall mean yield by 26.13%.

**Table 2a. Mean performance of 7 sesame genotypes (combined over two seasons)**

| Genotype | DTFPF | DTM | PH |
|---|---|---|---|
| Ziraa-9 | 44.60a | 85.60b | 115.00b |
| Kenana-2 | 36.90c | 81.80c | 105.70cd |
| Khidir | 36.90c | 82.50c | 110.20bc |
| Promo | 37.50c | 82.60c | 95.80e |
| Um shagara | 37.60c | 80.00d | 101.50de |
| Gedaref-1 | 41.40b | 87.10a | 122.50a |
| SPS2003T10 | 35.10d | 77.80e | 70.00f |
| C.V% | 1.85 | 0.71 | 4.65 |
| Mean | 38.56 | 82.49 | 102.95 |

DTFPF≡ Days to 50% flowering, DTM≡ Days to maturity, PH ≡ Plant height.

Means in columns having the same letter(s) are not significantly different at $P \leq 0.05$, according to Duncan's Multiple Range Test.

Yield is a complex polygenic quantitative character, greatly influenced by environment. Hence, selection of superior genotypes based on yield *per se* is not likely to be effective, but selection based on the components of yield may lead to its improvement. Thus, association of plant characters with yield assumes special importance in deciding the basis of selection. In this study, the higher values of the genotypic correlation coefficients, as compared with the phenotypic ones, may be due to the fact that the phenotypic associations between the different characters were reduced and modified under the influence of the environment. Similar conclusions were reached by Valarmathi *et al.* (2004) and Ali *et al.* (2010). The variation in the degree and significance of the estimates of the genotypic and the phenotypic correlations of some traits in the two seasons may be attributed to the fact that estimates of the phenotypic correlations are dependent on the environmental conditions.

**Table 2b. Mean performance of 7 sesame genotypes (combined over two seasons)**

| Genotype | NCPP | SYPP | SYPH |
|---|---|---|---|
| Ziraa-9 | 40.60ab | 5.30b | 361.00c |
| Kenana-2 | 4O.60ab | 5.74b | 534.00ab |
| Khidir | 36.30bc | 5.46b | 545.00ab |
| Promo | 31.10bc | 5.12bc | 441.00bc |
| Um shagara | 38.80ab | 5.83b | 454.00bc |
| Gedaref-1 | 49.30a | 7.34a | 391.00c |
| SPS2003T10 | 26.40c | 3.98c | 394.00c |
| C.V% | 18.41 | 14.72 | 14.28 |
| Mean | 37.57 | 5.53 | 474.39 |

NCPP≡ Number of capsule per plant, SYPP≡ Seed yield per plant and SYPH≡ Seed yield per ha.

Means in columns having the same letter(s) are not significantly different at $P \leq 0.05$, according to Duncan's Multiple Range Test.

The positive interrelationship between yield and plant height, number of capsules and seed yield per plant in both seasons (Tables 3) indicates that these attributes are the most important components of seed yield, and thus direct selection for these characters may improve seed yield of the crop. Similar conclusions were drawn by Muhammed and Dorairaj (1964), Reddy *et al.* (1993), Sarwar and Haq (2006) and Parameshwarappa *et al.* (2009).

The positive interrelation between yield and days to 50% flowering, days to maturity, plant height and number of capsules per plant, on one hand and between each other, on the other hand, was expected since the early maturing genotypes will be tall and bearing more capsules leading to high yield. This result agrees with the result reported by Ercan *et al.* (2002) and Sumathi *et al.*(2007).

**Table.3-. Genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficients between 6 pairs of characters in sesame, season 2008/ 09 and 2009/ 10.**

| Character | DTFPF | DTM | PH | NCPP | SYPP | SYPH |
|---|---|---|---|---|---|---|
| | | | Season 2008/09 | | | |
| DTFPF | - | 0.877** | 0.592** | 0.470* | 0.203 | -0.300 |
| DTM | 0.868** | - | 0.671** | 0.458* | 0.521** | 0.124 |
| PH | 0.550** | 0.634** | - | 0.920** | 0.751** | 0.509** |
| NCPP | 0.341 | 0.375* | 0.819** | - | 0.840** | 0.687** |
| SYPP | 0.163 | 0.474* | 0.718** | 0.804** | - | 0.960** |
| SYPH | -0.294 | 0.095 | 0.493** | 0.578** | 0.843** | - |
| | | | Season 2009/10 | | | |
| DTFPF | - | 0.761** | 0.745** | 0.693** | 0.583** | 0.284 |
| DTM | 0.748** | - | 0.941** | 0.874** | 0.829** | 0.863** |
| PH | 0.728** | 0.913** | - | 0.959** | 0.826** | 0.921** |
| NCPP | 0.624** | 0.760** | 0.910** | - | 0.979** | 0.959** |
| SYPP | 0.482** | 0.681** | 0.765** | 0.919** | - | 0.930** |
| SYPH | 0.243 | 0.676** | 0.810** | 0.084 | 0.816** | - |

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

DTFPF≡ Days to 50% flowering, DTM≡ Days to maturity, PH ≡ Plant height,

NCPP≡ Number of capsules per plant, SYPP≡ Seed yield per plant and SYPH≡ Seed yield per ha.

Based on the results obtained in this study , it could be concluded that most of the yield components were affected significantly by the genotype, season and their interaction and all of them exhibited strong relationship with seed yield/ha phenotypically and genotypically in both seasons. Therefore, to improve seed yield in sesame, emphasis should be made on selection of early tall plants with more capsules and higher seed yield.

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# التفاعل بين الطرز الوراثية والمواسم و الارتباط بين صفات بعض طرز السمسم تحت ظروف الري المطري في السودان

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الخلاصة

أجريت تجربة زراعية بمحطة أبحاث القضارف الزراعية لموسمين مطريين2008 /2009 و 2009/ 2010م لتقدير التفاعل بين الطرز الوراثية والمواسم ولتحديد الارتباط لسبعة طرز وراثية من السمسم المحلي. استخدم تصميم القطاعات العشوائية الكاملة بأربعة مكررات لتنفيذ التجربة .جمعت بيانات عن عدد الأيام حتى 50% إزهار وعدد الأيام حتى مرحلة النضج وطول النبات وعدد الكبسولات للنبات وإنتاجية النبات والإنتاجية للهكتار. أظهرت.كل هذه الصفات فروقات وراثية عالية المعنوية بين الطرز الوراثية .عدد الأيام حتى 50% إزهار وعدد الأيام حتى مرحلة النضج أظهرتا فرو قات معنوية على مستوى المواسم وعلى مستوى التفاعل بين الطرز والمواسم..بينما أظهرت إنتاجية النبات فروقات معنوية على مستوى المواسم. تفوق الطراز قضارف 1 في الإنتاجية على المتوسط العام للإنتاجية بنسبة 26.15%. . ارتبطت إنتاجية المحصول في الموسمين ارتباطا مظهريا ووراثيا موجبا مع كل من عدد الأيام حتى 50% إزهار وعدد الأيام حتى مرحلة النضج وطول النبات وعدد الكبسولات للنبات وإنتاجية النبات. كما أوضحت هده الصفات علاقات ارتباطية مظهرية ووراثية موجبة مع بعضها البعض. استنتج من هده النتائج أن إنتاجية محصول السمسم تتأثر متغيرا بالموسم وانه لتحسين إنتاجيتة يجب التركيز على انتخاب نباتات مبكرة النضج وطويلة السيقان وذات عدد أكبر من الكبسولات وإنتاجية عالية للنبات.