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Determining the interaction of G × S and assessment of characters association for some morphological traits and seed yield

Tamal Chakraborty and Amal Kumar

Faculty of Agricultural and Environmental Science, P. O Box 449, Gedaref, Sudan.

Abstract

The experiment was carried out at Gedarif Agricultural Research Station Sudan, during the rainy seasons 08/09 and 09/2010, to estimate the genotype x season interaction and to asses the characters association for seven sesame genotypes. A randomized complete block design with four replicates was used. The parameters were days to 50% flowering, days to maturity, plant height, number of capsules/plant, seed yield/plant (g) and seed yield/ ha (kg). All characters showed highly significant differences at the genotypic level, the days to 50% flowering and to maturity revealed significant differences at both seasons and the G × S interaction levels, whereas the seed yield / plant showed significant differences at the season level .Gedaref -1 out yielded the overall mean by 26.15%. In both seasons, the seed yield (kg/ha) was significantly and positively correlated with days to maturity, plant height, number of capsule/plant, seed yield/plant at both the genotypic and the phenotypic levels. From this study: to improve seed yield in sesame, emphasis should be made on selection tallest plants with more capsules and high yielder genotypes.

Keywords: G x S interaction, correlation coefficients, characters, sesame genotypes.

INTRODUCTION

Sesame (*sesamum indicum* L.) is a diploid species (2n = 26), a member of the family *Pedaliaceae* . Known as Beniseed, Gingelly, Sim-sim and Til. It is grown throughout the tropic and sub-tropic from 25°N to 25°S (Ashri, 1998). The origin of sesame is Africa, and from there spread through West Africa to India, China and Japan which themselves become secondary distribution centers (Ramanathan, 2004).

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

The phenotypic performance of a genotype is influenced by its genetic constituents, environments and their interactions. The detection of 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 another environment. Significant genotype by environment interaction for characters viz: 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; and John 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, 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 including 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 and Kandasamy et al, 1990). On the other hand, plant height, number of branches and capsule number depicted a negative association with seeds per capsule (Reddy, 1986). The objectives of this study are to determine the interaction of G × S and to asses the characters association for some morphological traits, seed yield and its components in seven sesame genotypes under rain-fed condition of the Sudan.

MATERIALS AND METHODS

Location

Gedarif State is located in the eastern part of the Sudan Latitude 14°1' 20''N, Longitude 35° 21' 45''E, elevation 592 meters above the sea level. The soil is classified as Vertisol characterized by dark heavy cracking clay (75%) with low organic matter and low nitrogen contents (Blokhuis, 1993). The climate is semi-arid, rainfall is 300 to 500 mm in the North and 600 to 900 mm per year in the South Mean temperature is 20° C. in winter and 40°C in summer.

Experimental design and treatments

A field experiment was conducted for two consecutive seasons: 2008/2009 and 2009/2010 at Sesame Research Center Farm, Gedarif, Sudan. In each season a randomized complete block design with four replications was used for laying out the field experiment. Each block was divided into 7 plots, to which the genotypes were assigned randomly. The plot size was 2.4 × 5 meters. Each genotype was represented by four rows, each five meters long and 0.6 meters apart. Seven sesame genotypes from Sesame Research Center were used. The seeds were sown in furrow along the row manually. Sowing date was on 18 July for the first season and on 14 July for the second season. The plants were thinned to 24 plants/m^2 three week after sowing. The experimental area was kept free of weeds in both seasons. No pest infestation was observed. Nitrogen fertilizer in form of urea was applied at a rate of 80 kg /ha.

Parameters were collected on the following data: Days to 50% flowering (DTFPF), days to maturity (DTM),plant height (cm) (PHT), number of capsules /plant (NCPP), seed yield /plant (g) (SYPP) and seed yield (kg/ha) (SYkg/Ha)

Statistical analysis

The data were subjected to the combined analysis to estimate the variance of genotypes x season’s interaction according to the standard statistical procedure described by Gomez and Gomez (1984). Duncan's Multiple Range Test (DMRT) was used to compare treatment means using the computer program MSTAT-C. The phenotypic and the genotypic correlation between all possible pairs of different characters were estimated, according to the formula of Miller et al. (1958) as follows:

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

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

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 significant differences for all characters at the genotype level. In addition, the days to 50% flowering and the days to maturity were highly significant at both seasons and the interaction of the seasons x the genotype levels, whereas, seed yield / plant was significant at the season level only. The significant interaction for the above mentioned characters suggest 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. This result confirms the findings of Perkins and Jinks (1968), John and Nair (1993) and Solanki and Gupta (2000). 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). The earliest genotype was SPS2003T10 (77.80 days), whereas, the latest one was Gedaref- 1 (87.10days). The highest yielder genotype was Gedref- 1 (591.00 kg/h), whereas, the lowest yielder was Ziraa - 9 (361.00 kg/h) (Table 2). Gedaref-1 out yielded the overall mean yield by 26.13%.

Yield is a complex polygenic quantitative character, greatly influenced by environment. Hence selection of superior genotypes based on yield is not likely to be effective. Selection is made on the components of yield. Hence association of plant characters with yield assumes special importance in deciding the basis of selection of desired characters. In this study, the higher values of the genotypic correlation coefficients, as compared to the phenotypic ones, may be due to the fact that the inheritance 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).

Table 1. Mean squares for genotypes, season and their interaction of 6 characters in 7 sesame genotypes grown at Sesame Research Center.

Character	Genotypes	Season	Season X genotypes
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.

Table 2. Mean performance of 7 sesame genotypes grown at Gedaref Sesame Research Centre (combined over two seasons 08/09- 09/2010).

Genotype	DTFPF	DTM	PH	NCPP	SYPP	SYTPH
Ziraa-9	44.60A	85.60B	115.00B	40.60AB	5.30B	361.00C
Kenana-2	36.90C	81.80C	105.70CD	4O.60AB	5.74B	534.00AB
Khidir	36.90C	82.50C	110.20BC	36.30BC	5.46B	545.00AB
Promo	37.50C	82.60C	95.80E	31.10BC	5.12BC	441.00BC
Um shagara	37.60C	80.00D	101.50DE	38.80AB	5.83B	454.00BC
Gedarif-1	41.40B	87.10A	122.50A	49.30A	7.34A	391.00A
SPS2003T10	35.10D	77.80E	70.00F	26.40C	3.98C	394.00C
C.V%	1.85	0.71	4.65	18.41	14.72	14.28
Overall mean	38.56	82.49	102.95	37.57	5.53	474.39

Means within the column sharing similar letter(s) are not significant different at probability level of 0.05 according to Duncan's Multiple Range Test (DMRT).

Table 3a. Genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficient between 6 pairs of characters in sesame, Season 2008/2009.

Characters	DTFPF	DTM	PH	NCPP	SYPP	SYKg/Ha
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**
SYKg/Ha	-0.294	0.095	0.493**	0.578**	0.843**	-

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

The variation in the degree and significant of the estimates of the genotypic and phenotypic correlations of some traits between the two seasons may be attributed to the fact that estimates of the phenotypic correlation are dependent on the environmental condition.

The positive interrelationship between yield with plant height, number of capsules and seed yield per plant in both seasons (Tables 3a and b) indicate that these attributes are the most important components for seeds yield and the 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 days to 50% flowering and days to maturity with plant height and number of capsules per plant was expected results since the late maturing genotypes will be tall and bearing more capsules. This result was agreed with those results reported by Ercan (2002) and Sumathi et al. (2007).

Table 3b. Genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficient between 6 pairs of characters in sesame, season 2009/2010.

Character	DTFPF	DTM	PH	NCPP	SYPP	SYKg/Ha
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**
SYKg/Ha	0.243	0.676**	0.810^^	0.084	0.816**	-

*, ** Significant at 0.05 and 0.01 probability level, respectively. DTFPF≡ Days to fifty percent flowering, DTM ≡ Days to maturity, PH ≡ Plant height, NCPP ≡ Number of capsule per plant, SYPP ≡ Seed yield per plant and SYKg/Ha ≡ Seed yield Kg/Ha.

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